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COMMENTS OF ORMET CORPORATION

ON THE PROPOSED REMEDIAL ACTION PLAN

FOR THE ORMET CORPORATION SUPERFUND SITE

JUNE 9, 1994

APPENDICES VOLUME I

ECKERT SEAMANS CHERIN & MELLOTT

ATTORNEYS AT LAW

April 19, 1994

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Elizabeth Murphy, Esq.
Assistant Regional Counsel
Region V
United States Environmental
Protection Agency (CS-3T)
77 West Jackson Boulevard
Chicago, Illinois 60604-3590

RE: Ormet Corporation

Dear Ms. Murphy:

This will confirm our understanding that pursuant to 40 C.F.R. § 300.430(f)(3)(C) of the National Contingency Plan, Ormet has requested and has been granted an extension of time to June 11, 1994 to submit its comments regarding the Proposed Remedial Action Plan (PRAP) for the Ormet site. Given the significant number of units which are addressed by the PRAP and the complexity of several of the issues which are raised, Ormet will need the additional time to adequately prepare its comments. At this time it appears that the additional thirty days should be adequate.

We appreciate your consideration in this regard.

Sincerely,

Richard S. Wiedman

RSW/*fma*

cc: Ms. T. G. Hyde
Mr. J. D. Reggi

Pittsburgh
Harrisburg
Allentown
Philadelphia
Boston
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ORMET

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November 7, 1991

Ms. Rhonda E. McBride
Environmental Engineer
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U.S. Environmental Protection Agency
Region V
CERCLA Enforcement Section
230 South Dearborn Street
Chicago, IL 60604

Mr. Richard J. Stewart
Project Coordinator
Ohio Environmental Protection Agency
Division of Solid and Hazardous
Waste Management
Southeast District Office
2195 Front Street
Logan, OH 43138

RE: Dispute Resolution Under the Ormet Corporation Administrative Order By Consent Re: Remedial Investigation And Feasibility Study; U.S. EPA Docket No. V-W-87-013

Dear Ms. McBride and Mr. Stewart:

Pursuant to Section XX of the above-referenced Administrative Order By Consent (the "CO"), Ormet Corporation ("Ormet") is hereby invoking the dispute resolution procedures provided therein. As required by Section XX of the CO, this letter identifies the specific points of the dispute, Ormet's position regarding this dispute, the bases for Ormet's position and the actions Ormet considers to be necessary.

This Notice of Dispute concerns the revised Baseline Risk Assessment ("BRA") prepared for the United States Environmental Protection Agency ("EPA") by its contractors Donahue & Associates, Inc. and Life Systems, Inc. (collectively referred to as "Life Systems") for the Ormet Site. As detailed below, the revised BRA is false and misleading, and relies on incorrect and improperly manipulated data to reach erroneous conclusions. The most glaring of these errors include the totally unsubstantiated conclusion that there may be an elevated risk of cancer at off-site receptors located in Proctor, West Virginia and the use of patently absurd and inapplicable exposure assumptions in calculating potential risk.

A review of the BRA discloses that notwithstanding Life Systems' apparent intent, no study of potential impacts in Proctor, West Virginia, in fact, occurred. Moreover, any competent analysis of the collected data clearly demonstrates that there is no such risk in Proctor. The fabricated risk contained in the BRA is the direct result of the failure to run the Fugitive Dust Model ("FDM") as it was designed, the failure to perform a model validation assessment on the the Life Systems work and the failure to properly calibrate the model used.

The BRA also contains exposure assumptions and scenarios which on their face contradict the mandate of the National Contingency Plan and EPA guidance. There is absolutely no reasonable basis for evaluating a future residential use scenario or calculating a risk factor based upon subsistence fishing from the Ohio River. Rather, it appears that the BRA has been manipulated in such a way as to grossly mischaracterize and overestimate the potential risk presented by Site conditions.

We are disturbed by the apparent cavalier attitude which has been taken toward this matter and consider the failure to adequately address the deficiencies in the BRA to be an abdication of EPA's obligation to prepare a BRA and a breach of the CO. The importance of this issue to Ormet and the severity of the irreparable harm which Ormet will suffer if this is not corrected cannot be overemphasized. The specific errors and points of dispute are outlined below and detailed in the technical evaluations attached to this Notice of Dispute.

In the interests of all those concerned with the integrity of this process, Ormet is providing the data and other information necessary to properly revise the BRA consistent with and as mandated by the CO. As always, we are prepared to make our technical consultants available to discuss these issues in the hope that this matter can be amicably resolved and the remedial investigation ("RI") completed.

A. <u>Specific Points Of Dispute</u>

The specific actions which form the bases for this Notice of Dispute are as follows:

1. Notwithstanding the agreement between Ormet, the Ohio Environmental Protection Agency ("Ohio EPA") and EPA (sometimes referred to collectively as the

"Agencies") the Fugitive Dust Model ("FDM") was not implemented to model air transport of fugitive particulate matter ("PM_{10}") from potential source areas at the Ormet Site;

2. The BRA contains erroneous conclusions and statements about the potential risks associated with emissions of fugitive particulate matter from the Site;

3. The modeling work performed by Life Systems is not valid, the so called reality check which is required and was agreed upon has not been performed and the model was not calibrated;

4. Exposure assumptions have been manipulated so as to grossly overestimate the potential exposure associated with Site conditions; and

5. The BRA as currently drafted contains mistakes and deficiencies which are so significant that it is unacceptable for purposes of the RI and which render the BRA potentially more destructive and damaging to the community and Ormet than any risks, real or imagined, which are related to Site conditions.

B. The Bases For Ormet's Position

Under Section IV, Task 2(D) of the Statement of Work ("SOW") attached to and made a part of the CO, EPA committed to perform the BRA. All work performed under the CO, including work performed pursuant to the SOW, is to be "conducted in accordance with the NCP, [EPA's "Guidance on Remedial Investigations Under CERCLA," dated May, 1985, as amended, EPA's "Guidance on Feasibility Studies under CERCLA," dated April, 1985, as amended], any additional guidance documents provided by U.S. EPA which are not inconsistent with the NCP, and the requirements of [the CO] . . . ." See CO, Section IX, Paragraph I. The BRA prepared by Life Systems fails to conform to these standards, is invalid and reflects insupportable scientific and technical conclusions. Accordingly the BRA, as drafted, does not satisfy the requirements of the CO and cannot be included in the RI Report.

1. Failure To Perform A Valid Evaluation Of The Air Exposure Pathway

At our meeting on April 11, 1991, the nature of the gross errors associated with Life Systems' so called air modeling work and the magnitude of the potential ramifications of these errors were brought to the Agencies' attention. At that time the Agencies caucused for over an hour and then agreed to address and correct these errors. Ormet agreed to make its modeling consultant, Energy and Environmental Management, Inc. ("E^2M") available to assist the Agencies' over-sight contractor, Metcalf & Eddy ("M&E"), in understanding the nature of the deficiencies and in making the necessary corrections to properly implement the FDM. At a significant cost in time, effort and money, Ormet instructed E^2M to work with the Agencies and M&E. Despite these efforts, it is apparent that these issues were not addressed. Rather than facing these obvious technical and scientific problems head-on, it is also apparent that significant resources have been wasted simply attempting to obscure the fact that the air modeling work is invalid and that the conclusions in the BRA are totally unsubstantiated and, in fact, false. The BRA is invalid and, if not corrected, will create unjustified fear and panic in the community and subject Ormet to unwarranted accusations and attack.

a. Failure To Perform The Fugitive Dust Model

In August, 1990, EPA indicated an intent to utilize emission and dispersion modeling to predict exposure concentrations of PM_{10} at selected receptor points. See letter dated August 24, 1990, to Ormet from Rhonda E. McBride, EPA Remedial Project Manager and Richard Stewart, Ohio EPA Site Coordinator dated August 24, 1990 (Attachment "A"). At that time EPA indicated an intent to utilize the Industrial Source Complex Long Term ("ISCLT") Model for this modeling study. After discussions among Ormet, EPA and Ohio EPA, it was recognized that the FDM, identified by EPA on the Support Center for Regulatory Air Models Computer Bulletin Board, was the preferred model for analyzing potential exposure scenarios for fugitive emissions from Superfund Sites, and would more accurately model fugitive emissions from the Site. Therefore, it was agreed that the FDM would be used in conjunction with the BRA in place of the ISCLT Model.

The FDM was selected because emissions of PM_{10} from the Site depend upon the wind erosion effect on the potential source areas and the FDM provides for the use of a wind speed dependent emission rate which accounts for this effect. By comparison, the ISCLT model uses a constant predicted emission factor and, therefore, emission rates for PM_{10} from the modeled source area remain constant regardless of the fact that wind neither blows every day nor at the same speed on the days it does blow. This critical distinction between the FDM and ISCLT model is what makes the FDM particularly well-suited for modeling fugitive emissions from Superfund Sites. This, of course, presumes that the FDM is actually used in a given modeling exercise. As discussed in more detail in E^2M's evaluation, (See Attachment "B"), the so-called modeling work performed by Life Systems, stripped the FDM of this key feature. As a result, no credible modeling study was performed. The so called modeling work which was conducted and has been disingenuously referred to as the EPA-approved FDM, amounts to little more than a useless and counter-productive distortion which on the surface has been packaged to look like a legitimate modeling study, but, in reality, fails to satisfy even the most fundamental standards which any EPA-approved or scientifically validated method must meet.

b. Failure To Model Proctor, West Virginia

As discussed in more detail in Attachment "B", the Y-Axis of the coordinate system employed by Life Systems is the negative of the true value. This error resulted in the failure to actually model potential impacts in Proctor, West Virginia. Indeed, receptors R_3 and R_4 which were intended to be located in Proctor are actually located north of the Site on the opposite side of the Ohio River from Proctor. Thus, the Life Systems' modeling work does not include any receptors in Proctor and the statements contained in the BRA about impacts in Proctor are entirely false and unfounded since Proctor simply was never modeled.

c. Improper Source Segmentation

As discussed in more detail in Attachment "B", source segmentation guidelines require a source to receptor distance of three times the length of the side of the area modeled to minimize the overprediction of impacts at the receptor. The source segmentation used for Pond 5, the only source area modeled by Life Systems, does not even come close to meeting this 3 to 1

Rule with respect to monitoring point AM-2. This alone resulted in a significant overprediction of impacts at AM-2. The BRA at page A2-27 attempts to obscure the significance of this error by pointing out that Proctor is a significant distance from the source area. Without actual monitoring data from Proctor, however, there is no way to determine the extent to which the overestimation caused by the source segmentation error would carry over to a receptor located in Proctor. The attempt at hiding this deficiency behind unfounded conclusory statements is both disingenuous and unprofessional.

Life Systems could easily have eliminated this source segmentation error by adjusting the source segments used in its modeling study. Although source segmentation adjustments may take additional time, i.e., a matter of days, to achieve the correct 3 to 1 segmentation ratio, such additional time requirements hardly present a valid justification for ignoring this basic tenet of air modeling science.

d. Failure To Perform A Reality Check

In August, 1990, the Agencies acknowledged the need to calibrate the model used to predict impacts of fugitive emissions from suspected source areas and, in fact, expressed an intention to "utilize the air monitoring program as a "Reality" (sic) check . . . ." See Attachment "A". Moreover, a critical point in our discussions during the April 11 project review meeting centered on the need for a reality check on Life Systems' modeling work and calibration of the model used by Life Systems. Notwithstanding the Agencies' recognition of the need and commitment to perform a reality check and calibrate the model, no legitimate reality check or model calibration has been performed on Life Systems' modeling work. Even now when it is clear that the most rudimentary reality check provides overwhelming evidence of the gross errors and invalidity of the work performed by Life Systems, no effort has been made to either assess the model in accordance with generally accepted and recognized practices and procedures or to make corrections as dictated by such established practices and procedures. It is difficult to understand how so much time and effort has been wasted trying to obscure manifest errors rather than correct them.

As discussed in the E^2M Report, Attachment "B", evaluation of Life Systems' work using the recognized model performance criteria establishes the unacceptable quality of this work. Indeed, in the scientific community where acceptable results are expected to approach a positive correlation of 1.0, the correlation of Life Systems' work is actually negative!

Comparing Life Systems' predicted concentrations at monitoring point AM-2 to data collected at this monitoring location establishes that Life Systems' invalid modeling work overestimates true impacts by at least 550 percent. At a minimum this requires adjustments to the calculated results for off-site receptors to reflect the source segmentation error and the overprediction factor based upon the comparison to actual data. As discussed in Attachment "B", even this unsophisticated form of calibration results in the reduction of Life Systems' predicted maximum potential concentration to 1.18 ug/m^3.

Even if the work performed by Life Systems had some utility, the failure to properly perform a reality check on Life Systems' modeling work and make appropriate corrections in response thereto itself constitutes a breach of the Agencies' obligations under the CO and of the commitments made by the Agencies during the April 11 meeting. This failure to perform a reality check totally undermines the credibility of Life Systems' modeling study and the failure to calibrate the model used by Life Systems renders the results meaningless.

3. Mischaracterization Of Site Conditions And <u>Manipulation Of Exposure Assumptions</u>

The BRA contains assumptions about existing and hypothetical exposure scenarios for the Ormet Site which are patently unreasonable and inconsistent with EPA guidance. EPA defines the "reasonable maximum exposure" scenario as the "highest exposure that is <u>reasonably</u> expected to occur at a site." Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A) ("Risk Assessment Guidance"), pg. 6-4, (December, 1989) (emphasis added). Neither the overall characterization of the Ormet Site nor many of the individual exposure scenarios even remotely qualify as reasonable. Rather, exposure assumptions for the Ormet Site have been manipulated so as to grossly overstate the risk presented by Site conditions.

Ormet is an operating industrial facility situated in a rural but heavily industrialized area of Monroe County which is located in southeastern Ohio. Contrary to the blatantly erroneous statements contained in the BRA at page 3-5, Monroe County has experienced a population decline over the last eight years of 10.8 percent, and there is absolutely no basis for the statement that "future population growth of over 25 percent has been projected for the area." See Monroe County Census Data, Attachment "C". Likewise, the village of Hannibal is located over 3 miles away from the facility, not a "short distance (approximately 4,000 ft.) south of the Site." Moreover, restrictions on construction along the Ohio River and the proximity to the Consolidated Aluminum Corporation facility to the south and the several mile undeveloped area along the Ohio River to the north of the Site, not only contradict Life Systems' conclusions about the reasonableness of the hypothetical future residential use scenario for the Site contained in the BRA, but these factors make future residential use of the Site extremely unlikely.

With regard to future residential land use assumptions EPA guidance states:

> Assume future residential land uses if it seems possible based on the evaluation of the available information. For example, if the site is currently industrial but is located near residential areas in an urban area, future residential land use may be a reasonable possibility. If the site is industrial and is located in a very rural area with a low population density and growth, future residential use would probably be unlikely.

Risk Assessment Guidance at pg. 6-7 (emphasis added). The Agencies have chosen to overlook the fact that Monroe County is sparsely populated (census data for calendar year 1990 indicates a total population of 15,497) and what sparse population there is in the County is declining. Moreover, Ormet is a principal employer in Monroe County. If Ormet were no longer using the Site for its operations, population and, hence, demand for residential property, would decline even more rapidly than it is at the present. The BRA must reflect the fact that future residential use of the Site is such a remote possibility that it should not be considered in the risk evaluation process.

Similarly, there is no basis for including a subsistence fishing exposure scenario in the BRA. With regard to subsistence fish ingestion exposure scenarios, EPA guidance states that:

> In order to add subsistence fishing as a pathway of concern among residential scenarios, on-site contamination must have impacted a water body large enough to produce a consistent supply of edible fish, and there must be evidence that area residents regularly fish in this water body (e.g., interviews with local anglers).

EPA memorandum from Timothy Fields, Director, Office of Waste Programs, to Directors, Waste Management Divisions for EPA Regions I, IV, V and VII, et al., Re: Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors," OSWER Directive No. 9285.6-03 (March 25, 1991) (emphasis in original). No site-specific information concerning fishing practices in the Ohio River was gathered in connection with the BRA. Moreover, there are fishing advisories throughout the areas up and downriver of the Site. Inclusion of a subsistence fishing scenario, which is extremely unlikely and, in fact, actively discouraged, in the BRA is patently unreasonable.

4. Miscellaneous Deficiencies

The BRA contains numerous other unreasonable exposure assumptions, some contradicting EPA's own guidance and others bordering on the absurd. These scenarios and exposure assumptions are identified and discussed in detail in Geraghty & Miller's evaluation of this work, Attachment "D". The BRA must be revised in accordance with Attachment "D" to reflect reasonable exposure assumptions and scenarios and the fact that the Site is located in a rural, but industrialized area.

In addition, the BRA contains various other assorted mistakes and deficiencies which materially affect the substance of the information contained in the BRA. These items are identified and discussed in detail in Geraghty & Miller's evaluation of the BRA, Attachment "D". The BRA must be revised to reflect the changes identified and discussed in Attachment "D".

C. Action Requested

To date no valid air modeling study has been performed despite the expenditure of a great deal of time, effort and money. At Ormet's request, E^2M has conducted a valid and technically sound air modeling study utilizing the FDM as designed and as agreed upon. E^2M has also performed a reality check on this modeling study pursuant to EPA/AMS-approved procedures, which indicates that the results of this study are valid, i.e., a positive correlation of .9338 (significant at a one-tailed 0.001). A copy of the E^2M modeling study is provided in Attachment "B". Under the circumstances it appears that further efforts to correct the Life Systems' modeling work would be futile. Therefore, Ormet requests that the Agencies remove the Life Systems' modeling study and results and the disingenuous discussion of the reality check concept from the BRA. Ormet further requests that the E^2M modeling study and reality check be included in the BRA, that E^2M's results be used to properly predict potential impacts in Proctor, i.e., a potential cancer risk well below 1×10^{-6} (SeeReport of Geraghty and Miller, Attachment D), and that the discussion of off-site receptors in the BRA be revised consistent with this work.

Ormet has expended a great deal of time, effort and money to assist EPA and its contractors in preparing the BRA. Notwithstanding these efforts there has been blatant disregard of pertinent information and erroneous, misleading and unsubstantiated information has been included in the BRA in violation of the CO. Under such circumstances Ormet cannot be held responsible for the costs incurred by the Agencies and Life Systems in preparing, reviewing and approving the BRA.

The BRA, as presently drafted, improperly and wrongfully manipulates the risk evaluation process to grossly overestimate the potential risks associated with Site conditions. By approving the BRA, as drafted, the Agencies have committed the first step in a likely chain of events which will cause unnecessary and unfounded fear and anxiety among the general public and irreparable harm to Ormet. CERCLA, the NCP and the CO mandate that the BRA be revised consistent with this Notice of Dispute.

Very truly yours,

JD Reggi

John D. Reggi

cc: Mary Butler, Esquire
Cynthia Hafner, Esquire
Terese Gioia
Brian Blair
Gene Bolo, P. E.
Frank Jones, Ph.D.
Larry Simmons, P. E.
Richard S. Wiedman, Esquire

ATTACHMENT "A"

Letter Dated August 24, 1990
To Ormet Corporation From
Rhonda McBride And Richard Stewart

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

AUG 24 1990

John D. Reggi
Ormet Corporation
Route 7 P.O. Box 176
Hannibal, Ohio 43931

REPLY TO ATTENTION OF: 5HS-11

Re: Agencies Request for Additional RI Fieldwork

Dear Mr. Reggi:

Pursuant to Section XIII. of the Ormet Corporation Site RI/FS Consent Order the Agencies must request the Ormet Corporation to obtain additional information in efforts to adequately quantify the air pathway for inclusion into the Endangerment Assessment (EA) for the Ormet Corporation Site.

As you are aware, the Ormet Corporation Site EA is now underway. Initial air dispersion modeling strategies have identified the need for particle sizing analysis for input into the Cowherd (1985) Model. The Cowherd Model will be used to calculate an emission rate of PM_{10} from each waste area (the five (5) Disposal Ponds and the Potliner Storage Area). The absence of particle size distribution data presents a critical data gap. This letter offers Ormet the opportunity to decide to:

1. Conduct field sieving analyses of the six (6) waste areas, or

2. Provide an estimate of particle size based on soil boring information collected previously. Note: Soil borings were taken during the Phase I RI in the Potliner Storage Area.

The Agencies have chosen to utilize the emission modeling rather than utilize data obtained during the air monitoring for PM_{10} to calculate an emission rate, which was conducted at the Ormet Corporation Site from March, 1988 to December, 1988. The Agencies decision was based on the fact that the air monitoring sampling event measured all sources of particulates (the manufacturing areas, the five (5) waste areas, and any other sources in the area). The EA for Ormet, however, is concerned only with particulate emissions from the Potliner Storage Area, the five (5) dried Disposal Ponds and their contribution to inhalation exposures to both on-site and off-site receptors. As an example, a preliminary calculation utilizing available information and assumptions estimated a PM_{10} concentration of 11 mg/m^3 at the perimeter of Disposal Pond #5 at AM-2. This calculation was for Disposal Pond #5 only and is considerably less than the average monitored concentration of 42 mg/m^3 measured at AM-2. These preliminary calculations, subject to further refinement, are shown in Attachment #1. Essentially, the Agencies felt that utilizing this air monitoring data would significantly overestimate PM_{10} emissions. However, the Agencies do intend to utilize the air monitoring program results as a "Reality" check on the Cowherd Model.

In order to quantify the air pathway the Agencies have chosen to calculate the emission rates from the six (6) waste areas, and use the Industrial Source Complex Long Term (ISCLT) Model to predict PM_{10} at the exposure points of interest. Exposure point concentration can then be calculated on a chemical by chemical basis, assuming that each contaminant of potential concern detected in the Disposal Ponds is associated with PM_{10} on the same weight basis.

The other data required for the Cowherd (1985) Model can readily be obtained from the Phase I and II RI results or from photographs taken by Geraghty & Miller Inc., or Metcalf & Eddy Inc. These include the following:

1. Total area of each waste source
2. Estimates of the nonerodible portions of waste area
3. Annual average wind speed at the site (preferably for a period of five years)
4. Fastest mile wind speed (preferably for a period of five years)
5. Estimated number of disturbances of the ponds per month
6. Estimated roughness height for each pond

The Agencies chose the ISCLT Model to quantify the air pathway off-site, because it models annual impacts from area sources at distances greater than 100 meters from source. The PCGEMS version of this model will be utilized and requires air stability data from a nearby STAR station. STAR stations (usually located at airports), measure not only wind speed and directions but stability classes as well. The nearby STAR station to Ormet that closely resembles the wind rose prepared from the meteorological data available in the air monitoring report is that of the wind rose produced at Parkersburg, WV. Ideally, site-specific air stability classes would be more appropriate. However, it is unlikely that this information would have been collected at the site. (See Attachments #2A, #2B, and #3). Additionally, it must be recognized that the use of the Parkersburg STAR station in the model will introduce additional uncertainty. Preliminary air dispersion modeling strategies have identified the need for site-specific meteorological data. More specifically, annual average wind speed, wind direction by 16 sectors and air stability by classes for approximately a 5-year duration are required for the model inputs. These are the data contained in a STAR station file. If Ormet could provide this data in a summarized, usuable format it will be possible to input as much site-specific meteorological data as possible into the models without relying on the Parkersburg STAR station data. Any information provided to the Agencies would be greatly appreciated.

Since, the ISCLT Model is a long range transport model it will be used to calculate the PM_{10} concentrations at any exposure points selected for quantification at distances beyond 100 meters. For example, the nearest downwind receptor that must be evaluated is Proctor, WV. There are also on-site downwind receptors at other areas. For any exposure point calculations closer than 100 meters to the six (6) waste areas, the box model will be applied utilizing on-site wind data.

Should you have any questions please do not hesitate to call the respective project managers.

Respectfully submitted,

Rhonda E. McBride

Rhonda E. McBride
Remedial Project Officer
U.S. EPA

Rhonda E. McBride for

Richard Stewart
Site Coordinator
OEPA

cc: Bob Fargo, G&M, Inc.
Jack Ubinger Jr., Eckart, Seamans, Cherin & Mallot
Dr. Frank Jones, G&M, Inc.

ATTACHMENT "B"

Report Of Energy And Environmental
Management Dated November 5, 1991

Energy & Environmental Management, Inc.
P O Box 71, Murrysville, PA 15668-0071 (412) 733-0022 FAX (412) 733-0018

November 5, 1991 E2M-176-91

Mr. John D. Reggi
Ormet Corporation
Route 7
Hannibal, OH 43931

Dear Mr. Reggi:

Energy & Environmental Management, Inc. (E2M) has reviewed the final baseline risk assessment/human health evaluation dated August 8, 1991 that was prepared for the Hannibal, Ohio Ormet site by Life Systems, Inc. (LSI). Our review of that work discloses that the air modeling work incorporated into the baseline risk assessment is invalid. Our comments are limited to the Appendix A2 of that document and are found under the following headings:

- Implementation of the Model
- Model Coordinate System
- Source Segmentation
- Reality Check
- Conclusion
- Recommendation

IMPLEMENTATION OF THE MODEL

Very early in this project, we discussed the model to be used for dispersion of PM_{10} emissions from the suspect source area. LSI proposed the Industrial Source Complex Long Term (ISCLT) model. We proposed the Industrial Source Complex Short Term (ISCST) model because the validation data were available in 24-hour periods from the ten month monitoring program. Later we suggested and it was agreed that the Fugitive Dust Model (FDM) be used because EPA put the model on the Support Center for Regulatory Air Models (SCRAM) Bulletin Board with the specific recommendation that the model is appropriate for air pathways analysis at Superfund sites. When used properly, FDM has the flexibility to project PM_{10} emission rates under varying wind speeds. Dust emissions from the suspect source area are directly related to the wind speed. FDM has the capability of more nearly representing the time varying nature of the fugitive emissions from the ponds.

Unfortunately, LSI decided to not use this capability in the model, effectively negating a major technical benefit of using FDM. Their reason for stripping the FDM of this critical wind speed dependent emission rate was as follows:

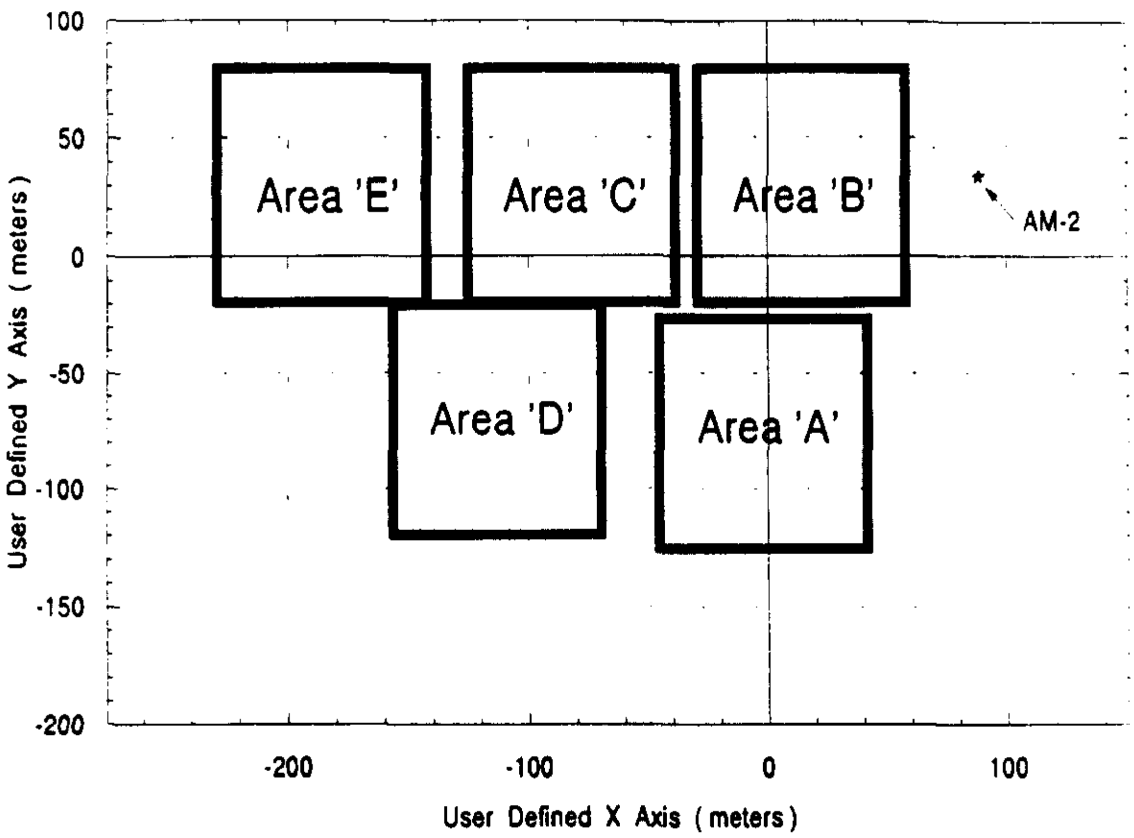
"The wind speed dependence factor selected is zero; although, emissions from these sources are dependent on wind speed, that dependence is accounted for in the emission rate calculation."

The LSI reasoning is flawed and would only apply at the mean wind speed input to the unlimited erosion potential equation. Hour by hour wind speed variability is not included in the LSI calculated emission rate. This decision by LSI effectively violated the agreement between EPA and Ormet concerning the study plan and condemned the "Reality Check" to a meaningless function by using an annualized emission rate for comparison to specific days from the ten month PM_{10} monitoring program. The end result of this exercise by LSI is that no model has been properly used and, as a result gross technically invalid and insupportable over-predictions have been incorporated into the Risk Assessment.

MODEL COORDINATE SYSTEM

During our review of the LSI data file as shown in Table A.2-3 of the Risk Assessment, we found a serious and fatal error in the model input file. That error can best be seen by comparing Figure A2-1 (page A2-10 of Risk Assessment) to the graphic representation of the five sources at Pond 5 in Figure 1 to this letter. Figure 1 derives its input data from Table A2-3 (page A2-9 of the Risk Assessment). What is significant in Figure 1 is that the User Defined Y-Axis is the negative value of the User Defined Y-Axis shown in Figure A2-1 (page A2-10 of Risk Assessment). LSI apparently modeled a mirror image of Pond 5 and the accompanying receptors. The model used an actual meteorological data set but erroneously used mirror image emission sources and receptors. Therefore, the model would be impacting AM-4 when in effect, AM-3 was the receptor that was affected on that day. In effect, LSI modeled R_3 and R_4 as receptors in Ohio and not in West Virginia where these receptors were intended. This is illustrated in Figure 2 which is attached to this letter.

Comparison of FDM impacts to the values in Appendix 2 of the Risk Assessment is meaningless since Receptors R_3 and R_4 were actually located on the side of the hill north of Pond 5 and not in Proctor, West Virginia. This error, in and of itself, invalidates the FDM work done by LSI because the validation receptors are not properly located. Our evaluation will continue because the coordinates error mentioned here has a profound effect on the Reality Check discussed later.



Note: Relative size of each area is not to scale with respect to data from Table A2-3 (page A2-9) of Risk Assessment. A direct comparison of this diagram to Figure A2-1 (page A2-10) of Risk Assessment reveals the Coordinates from the User Defined Y-Axis are -1 times the correct value.

Figure 1. Representation of the Five Area Sources as Designated by LSI to Represent Pond 5 PM_{10} Emissions.

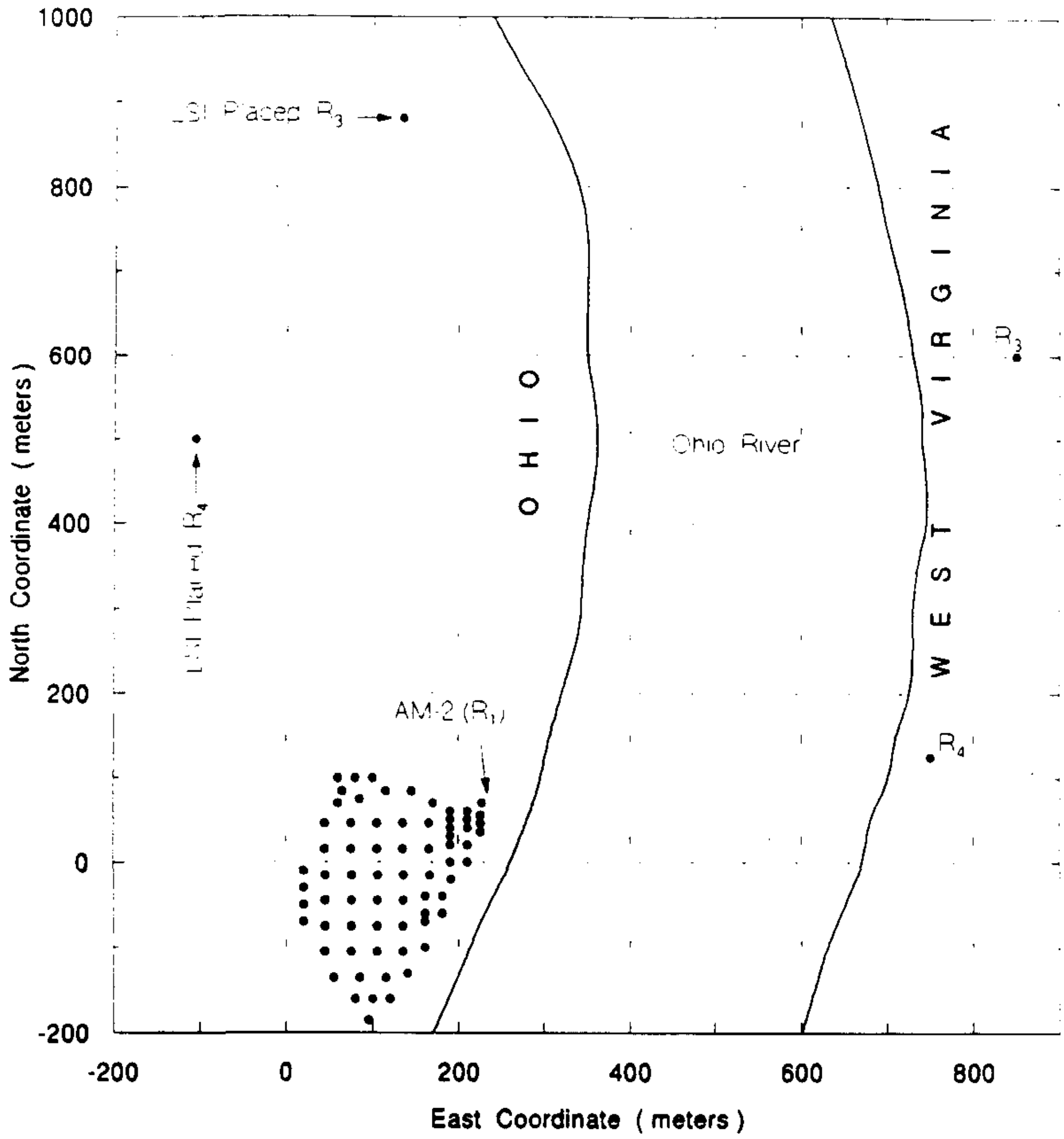


Figure 2. Pond 5 in Segment Mode and Receptors R_3 and R_4 Shown Where Intended and Where Placed in LSI FDM Input File.

(Boundary of Ohio River is Approximate.)

SOURCE SEGMENTATION

Figure A2-1 in Appendix A2 of the Risk Assessment presents the source segmentation for Pond 5 used by LSI as input to their work. AM-2 is a receptor point close to the source but is not shown in Figure A2-1. Site AM-2 can be seen in Figure 1 of Attachment 3 of this letter and is less than 10 meters from the northeast edge of Pond 5.

Source segmentation guidelines are provided in the Industrial Source Complex (ISC) Dispersion Model User's Guide, Volume I and apply to FDM. Source to receptor distance for a volume source is recommended to be three times the length of the side of the volume source in order to minimize prediction errors at the receptor. Prediction errors of impact at distances less than 3 to 1 fall within an unacceptable error range as per the ISC User's Guide. Source segmentation of Pond 5 does not meet this 3 to 1 criteria with respect to AM-2. This problem is mentioned on page A2-27 of the Risk Assessment. The Risk Assessment attempts to minimize this problem by stating the over-prediction at AM-2 would not extend across the river to Proctor, West Virginia. This statement is misleading since no PM_{10} data exist in Proctor to conduct a model performance evaluation. The only model performance evaluation data for this purpose are located at AM-2. Source segmentation should have reflected the proximity of AM-2 which, as noted previously, is less than 10 meters from the edge of Pond 5. To do otherwise simply ignores well established and accepted scientific principles.

As discussed later in this letter, AM-2 experienced significant over-prediction by LSI using an improper manipulation of FDM which stripped the model of its key features and the inadequate source segmentation shown in Figure A2-1. If LSI had used a more suitable source segmentation, the problems discussed in the next section would have been apparent to both LSI and Metcalf and Eddy (M&E).

REALITY CHECK

A key factor in our discussions with EPA concerned the importance of a proper "Reality Check" on the model performance. The generally accepted procedure for assessing model performance was developed through a cooperative agreement between EPA and the American Meteorological Society (AMS). To assist in the identification of possible measures of model performance, the AMS conducted a Workshop on Dispersion Model Performance at Woods Hole, Massachusetts on 8-11 September 1980.

Four measures of model performance came out of the Workshop and are now generally recognized. These are:

1. Bias, or average difference between observed and calculated concentrations;

2. The noise, or variances of the differences;

3. Root Mean Square Error; and,

4. Linear Correlation Coefficient between observed and calculated concentrations.

We have used each of these measures in various modeling studies. However, we have found the Linear Correlation Coefficient to be the most useful. The Linear Correlation Coefficient which ranges in absolute magnitude from 0 (no correlation between observed and calculated concentrations) to 1.0 (perfect correlation), is a measure of the degree to which the magnitude of the model predictions increases linearly with the magnitude of the observations.

The so called "Reality Check" discussed in Appendix A2 of the Risk Assessment is little more than a discussion of the concept. It does not reflect a reality check or model validation and only obscures the fact that no validation was done. None of the four AMS model performance measures was utilized in Appendix A2. We addressed this oversight by conducting a model performance evaluation of our own. We used the Linear Correlation Coefficient as a measure of model performance using the results summarized in Table 1 to this letter which was reproduced from the table at page A2-26 of the Risk Assessment. Also, we included the same performance measure for the FDM analysis reported in E^2M-060-91 (Attachment 3 of this letter). E^2M-060-91 is our report of a properly conducted FDM analysis of the subject area which we undertook with sources and receptors located as intended. The Linear Correlation Coefficient for each run as presented in Table 1 of this letter is listed below:

Run	Linear Correlation Coefficient
LSI-1	-0.8416*
LSI-2	-0.8825*
LSI-3	-0.9036*
E^2M	+0.9338**

The statistical analyses that developed the above correlations are presented in Attachment 1 to this letter for the five runs conducted by E^2M to determine a final emission rate and in Attachment 2 to this letter for the three runs conducted by LSI. A single asterisk

TABLE 1

PM_{10} 24-HOUR IMPACTS AT AM-3 AND AM-4 USING FDM UNDER VARYING EMISSION RATES AND FOR SELECTED DAYS FROM TEN MONTH PM_{10} FIELD DATA

		PM_{10} Values in $\mu g/m^3$			
		AM-3		AM-4	
Run*	Date+	Model	Measured**	Model	Measured**
LSI-1	04/10	4.1	6.6	0.01	6.0
	04/22	7.3	2.0	2.6	4.9
	08/31	32.4	0.2	1.2	7.3
	09/24	14.5	1.5	2.1	5.2
LSI-2	04/10	20.9	6.6	0.1	6.0
	04/22	39.4	2.0	8.9	4.9
	08/31	106.0	0.2	6.5	7.3
	09/24	57.0	1.5	7.9	5.2
LSI-3	04/10	15.7	6.6	0.1	6.0
	04/22	32.5	2.0	6.8	4.9
	08/31	71.6	0.2	5.9	7.3
	09/24	44.0	1.5	6.2	5.2
E^2M	04/10	8.997	6.6	6.939	6.0
	04/22	5.810	2.0	8.849	4.9
	08/31	3.080	0.2	10.620	7.3
	09/24	3.970	1.5	8.059	5.2

* LSI-1 Pond 5 Emission Rate = 0.34047 grams/second.

LSI-2 Pond 5 Emission Rate = 0.34047 grams/second with no deposition.

LSI-3 Pond 5 Emission Rate was allowed to vary to the power of 1.9.

E^2M Ponds 4 & 5 Emissions = 3.32E-7 $WS^{2.8617}$, where WS is wind speed. This is the last of 5 runs used to develop this equation (see Attachment 3 of this letter) as the most appropriate to represent the PM_{10} emissions from the suspect source area.

** Measured is downwind minus upwind.

\+ Dates selected based on screening modeling presented in Attachment 3 to this letter.

means the correlation is significant at a one-tailed 0.01. A double asterisk means the correlation is significant at a one-tailed 0.001. What is important in the above Linear Correlation Coefficient is that each LSI correlation is negative. The LSI correlation tells us that their model predictions decrease linearly with the magnitude of the observation. This is in direct conflict with the AMS model performance criteria, and demonstrates that the LSI work is simply invalid. This is also shown in Figure 3 to this letter.

A review of the data from Table 1 (Page A2-26) using any of the accepted performance criteria clearly reveals that the LSI work is unacceptable. In the case of the Linear Correlation Coefficient, it does not require a particularly sophisticated review to confirm the negative value. LSI improperly modeled the highest values at the sites experiencing the lowest estimated impact. Note that the E^2M correlation is positive, is statistically significant and complies with the AMS model performance criteria. The analysis conducted by Life Systems, Incorporated fails the generally accepted model performance criteria. In fact, there are no validated models discussed in either of the two listed EPA publications where any model has a statistically significant negative correlation to the field data:

> Environmental Protection Agency, 1984. Interim Procedures for Evaluating Air Quality Models (Revised). EPA Publication No. EPA-450/4-84-023. U.S. Environmental Protection Agency, Research Triangle Park, NC. (NTIS No. PB 85-106060).
>
> Cox, W.M., 1988. Protocol for Determining the Best Performing Model. U.S. Environmental Protection Agency, Research Triangle Park, NC. (Docket No. A-88-04, II-I-19); Computer Sciences Corporation, 1990. Bootstrap System User's Manual (Docket No. A-88-04, II-I-33).

At this point in our review, you may wonder how the LSI results would look if a simple coordinate axis transform is undertaken and the User Defined Y-Axis error was corrected. We did correct this error and also included an increase in the source segmentation from five (5) sources at Pond 5 used by LSI to a total of 72 sources. Results of these corrections are shown in Figure 3 attached to this letter with the resulting Y-Axis correction. The correlation was only 0.2284 and was not statistically significant. However, those corrections represent a first step in the right direction of properly calibrating and using the model. A perfect correlation line is also shown in Figure 3. Our correlation was 0.9338, was statistically significant, was positive and is the only work which is acceptably close to the perfect correlation line.

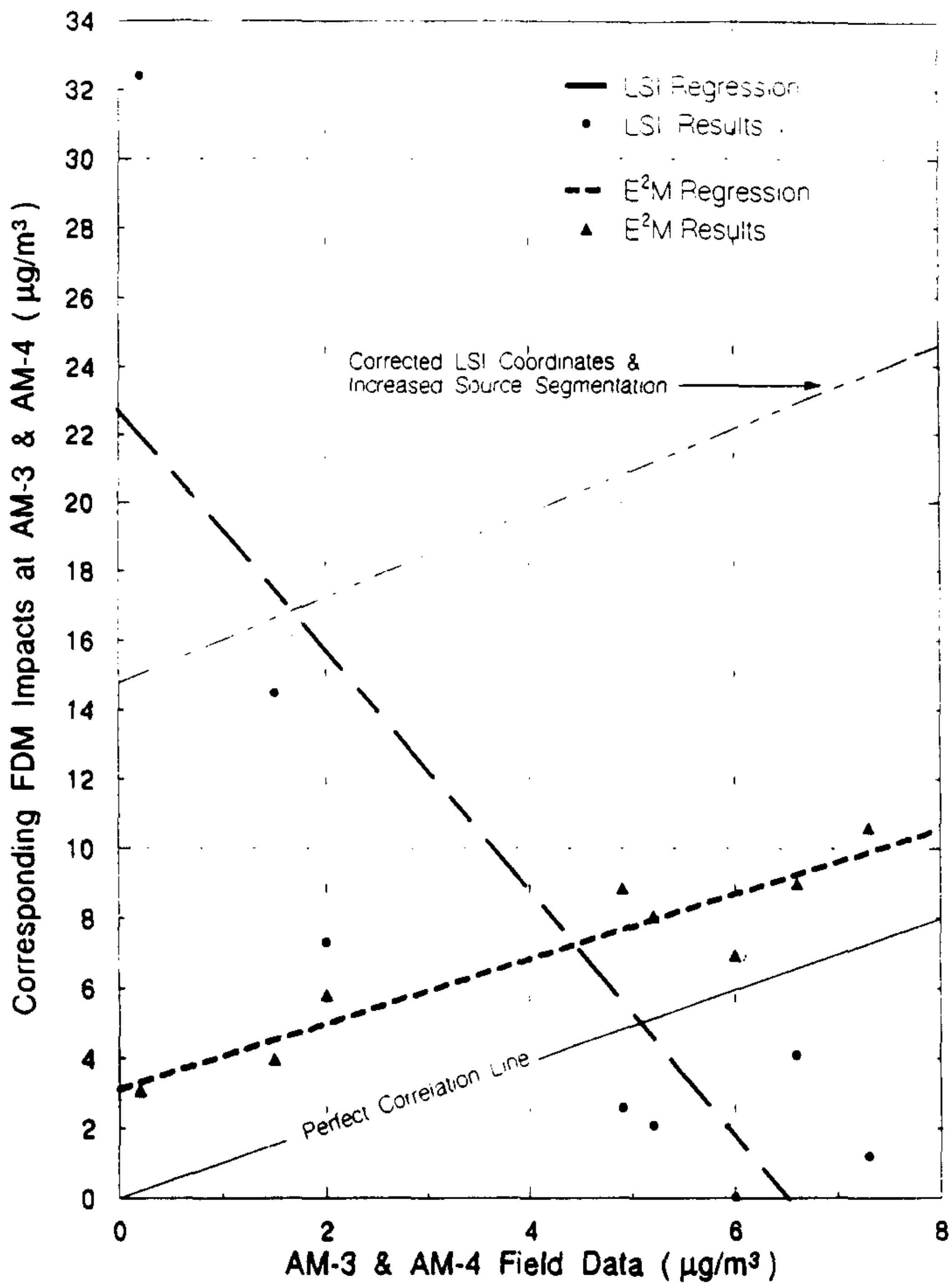


Figure 3. Comparison of LSI Run #1 Regression and E^{2}M Corrected LSI Run #1 to E^{2}M Regression of FDM Results from Attachment 3 Compared to Field Data.

Another disturbing aspect of the distorted work done by LSI and certified by M&E was the gross over-prediction at AM-2 and the failure to take any steps to properly calibrate the model in response. Obviously, reality checks are meaningless if appropriate steps are not taken in response to the check. While, for the reasons discussed above, LSI's work has no practical value for the modeling of any receptors, if one erroneously presumed that the data had some utility, M&E should at least have made adjustments to the work done by LSI by adjusting "so called" Proctor impacts by the over-prediction factor at AM-2. While this would in essence be the equivalent of using the more linear ISCLT model, it at least has some technical and scientifically supportable basis.

LSI modeled an annual average value of 277.6 $\mu g/m^3$ at AM-2 in contrast to the measured value of 42.5 $\mu g/m^3$. AM-2 is located in the dominant downwind direction from Proctor, West Virginia. At a minimum, an adjustment should have been made to take into consideration the inadequate source segmentation at Pond 5 and the necessary correction of the modeled impact. At a minimum, this over-prediction factor of over 550 percent should have been carried downwind and used to correct the LSI modeled impacts. Our review of the LSI data indicates that this 550 percent over-prediction substantially underestimates the magnitude of the error at AM-2 even if the other flaws in the LSI work were addressed. Even assuming the over-prediction factor was only 550 percent, at a minimum, the impact modeled by LSI at Receptors R_3 and R_4 should have been corrected to a true value that is greater than 0.63 $\mu g/m^3$ but less than 1.18 $\mu g/m^3$.

This analysis still improperly assumes that all PM_{10} measured at AM-2 originates from the affected source area. We know by inspection at the site that allowable in-plant process emissions and fugitive dust were also impacting AM-2 during the study. M&E discusses this as a confounding factor in the analysis. Our modeling effort determined the impact at AM-2 to vary from 22.63 to 23.47 $\mu g/m^3$, depending on 1989 and 1990 meteorological data (see Attachment 3 of this letter). We would then expect a properly validated model to yield results at AM-2 less than the measured value at AM-2 because only emissions from the subject source area are included in the modeling study. Obviously, the unlimited erosion potential emission rate used by LSI does not meet this criteria, over-predicting the measured value by 550 percent. The E^2M modeling results in Attachment 3 met this criteria, indicating the suspect source area impacts are only 53% of the total measured at AM-2. This is consistent with what one would expect at this type of site and adds credibility to the E^2M implementation of the FDM, validated with data from AM-3 and AM-4. We also expanded the analysis to include Receptor R_4 at the location intended by LSI. LSI's intended Receptor R_3 corresponded to our northern most Proctor receptor shown in Attachment 3. Attachment 4 contains the E^2M modeling impacts at Receptor R_4. The properly modeled maximum impact at receptors R_3 or R_4 in Proctor would be:

E^2M Modeled Value (See Attachments 3 and 4)
0.92 $\mu g/m^3$

CONCLUSION

The air quality modeling conducted by LSI and certified by M&E is fatally flawed because of incorrect implementation of the Fugitive Dust Model which resulted in a statistically significant negative correlation of modeled values to monitored values. This statistically significant negative correlation violates the generally accepted model performance tests as developed cooperatively between EPA and the American Meteorological Society. We can only conclude that the LSI study has no technical merit or scientific value.

RECOMMENDATION

We recommend that EPA conduct a revised air pathways risk assessment using the FDM study contained in Attachment 3. The FDM study presented in Attachment 3 meets the generally accepted model performance test of a statistically significant positive correlation of modeled values to monitored values.

Sincerely,

Larry L. Simmons

Larry L. Simmons, P.E.
Principal

LLS/das

CC: C-312

ATTACHMENT 1

STATISTICAL ANALYSIS OF VALIDATION DATA PREPARED BY ENERGY & ENVIRONMENTAL MANAGEMENT, INC. AND SUBMITTED TO ORMET CORPORATION AS PART OF ATTACHMENT 3

```
                SPSS/PC+ The Statistical Package for IBM PC                10/10/91
INC 'valid_1.prg'
*
* program to determine relationship between measured and modeled PM10
* values at CERCLA site at Ormet Plant in Hannibal, Ohio using E2M PM10
* data and FDM output from Table 2 of E2M-060-91 letter to J.D. Reggi at
* Ormet Corporation
*.
SET LENGTH = 59.
SET MORE = OFF.
DATA LIST /
  run 2 model 19-24 measure 26-31.
BEGIN DATA.
END DATA.
     40 cases are written to the compressed active file.

This procedure was completed at  2:34:25
save outfile = 'temp.sf'.
The SPSS/PC+ system file is written to
    file temp.sf
      6 variables (including system variables) will be saved.
      0 variables have been dropped.

The system file consists of:

        432 Characters for the header record.
        192 Characters for variable definition.
         16 Characters for labels.
       2048 Characters for data.
       2688 Total file size.

     40 out of     40 cases have been saved.

-------------------------------------------------------------------------------
Page   2                          SPSS/PC+                                 10/10/91

This procedure was completed at  2:34:26
get file = 'temp.sf'.
The SPSS/PC+ system file is read from
    file temp.sf
The file was created on 10/10/91 at  2:34:25
and is titled                       SPSS/PC+
The SPSS/PC+ system file contains
     40 cases, each consisting of
      6 variables (including system variables).
      6 variables will be used in this session.
-------------------------------------------------------------------------------
Page   3                          SPSS/PC+                                 10/10/91

This procedure was completed at  2:34:26
select if ( run = 1).
CORRELATION model measure.
The raw data or transformation pass is proceeding
      8 cases are written to the compressed active file.
-------------------------------------------------------------------------------
Page   4                          SPSS/PC+                                 10/10/91

Correlations:  MODEL      MEASURE

  MODEL        1.0000      .6279
  MEASURE       .6279     1.0000

N of cases:      8        1-tailed Signif:  * - .01  ** - .001

" . " is printed if a coefficient cannot be computed
-------------------------------------------------------------------------------
Page   5                          SPSS/PC+                                 10/10/91

This procedure was completed at  2:34:28
regression var = model measure
   /criteria pin(.1) pout(.15)
   /statistics = all
   /dependent = model
   /method = enter measure.
-------------------------------------------------------------------------------
Page   6                          SPSS/PC+                                 10/10/91

         * * * *   M U L T I P L E   R E G R E S S I O N   * * * *

Listwise Deletion of Missing Data

Equation Number 1    Dependent Variable..   MODEL

Block Number  1.  Method:  Enter      MEASURE

Variable(s) Entered on Step Number
   1..     MEASURE

Multiple R             .62786
R Square               .39421          R Square Change      .39421
Adjusted R Square      .29324          F Change            3.90435
Standard Error         .50466          Signif F Change      .0956

Analysis of Variance
                      DF      Sum of Squares       Mean Square
Regression             1              .99435            .99435
Residual               6             1.52807            .25468

F =        3.90435       Signif F =  .0956

AIC                 -9.24348
PC                   1.00966
CP                   2.00000
SBC                 -9.08460

Var-Covar Matrix of Regression Coefficients (B)
Below Diagonal:  Covariance      Above:  Correlation

                MEASURE

MEASURE          .00528

XTX Matrix

                MEASURE  |     MODEL

MEASURE         1.00000  |   -.62786
--------------------------------------
MODEL            .62786  |    .60579
-------------------------------------------------------------------------------
Page   7                          SPSS/PC+                                 10/10/91

         * * * *   M U L T I P L E   R E G R E S S I O N   * * * *

Equation Number 1    Dependent Variable..   MODEL
```

```
-------------------- Variables in the Equation --------------------

Variable              B        SE B     95% Confdnce Intrvl B      Beta

MEASURE          .143588    .072668    -.034223     .321399    .627858
(Constant)       .524511    .354317    -.342467    1.391489

------------------- Variables in the Equation --------------------

Variable      SE Beta   Correl  Part Cor  Partial  Tolerance       VIF

MEASURE       .317751  .627858  .627858  .627858   1.000000     1.000

---------- in -----------

Variable           T  Sig T

MEASURE        1.976  .0956
(Constant)     1.480  .1893

Collinearity Diagnostics

Number  Eigenval     Cond  Variance Proportions
                    Index  Constant  MEASURE
    1    1.86395    1.000    .06802   .06802
    2     .13605    3.701    .93198   .93198

End Block Number   1   All requested variables entered.


      * * * * * * * * * * * * * * * * * * * * * * * * * * * * *


                         Summary table
                         -------------

Step   MultR    Rsq    F(Eqn)  SigF       Variable  BetaIn
   1   .6279  .3942     3.904  .096  In:  MEASURE    .6279
--------------------------------------------------------------------------
Page   8                        SPSS/PC+                          10/10/91

This procedure was completed at  2:34:31
get file = 'temp.sf'.
The SPSS/PC+ system file is read from
     file temp.sf
The file was created on 10/10/91 at  2:34:25
and is titled                        SPSS/PC+
The SPSS/PC+ system file contains
     40 cases, each consisting of
      6 variables (including system variables).
      6 variables will be used in this session.
--------------------------------------------------------------------------
Page   9                        SPSS/PC+                          10/10/91

This procedure was completed at  2:34:33
select if ( run = 2).
CORRELATION model measure.
The raw data or transformation pass is proceeding
      8 cases are written to the compressed active file.
--------------------------------------------------------------------------
```



```
Page  10                        SPSS/PC+                          10/10/91

Correlations:   MODEL      MEASURE

  MODEL        1.0000      .6285
  MEASURE       .6285     1.0000

N of cases:       8         1-tailed Signif:  * - .01  ** - .001

" . " is printed if a coefficient cannot be computed
--------------------------------------------------------------------------
Page  11                        SPSS/PC+                          10/10/91

This procedure was completed at  2:34:34
regression var = model measure
   /criteria pin(.1) pout(.15)
   /statistics = all
   /dependent = model
   /method = enter measure.
--------------------------------------------------------------------------
Page  12                        SPSS/PC+                          10/10/91

         * * * *   M U L T I P L E   R E G R E S S I O N   * * * *

Listwise Deletion of Missing Data

Equation Number 1    Dependent Variable..   MODEL

Block Number  1.  Method:  Enter      MEASURE


Variable(s) Entered on Step Number
   1..    MEASURE


Multiple R            .62849
R Square              .39500          R Square Change    .39500
Adjusted R Square     .29416          F Change          3.91728
Standard Error       5.06520          Signif F Change    .0951

Analysis of Variance
                     DF       Sum of Squares      Mean Square
Regression            1          100.50264        100.50264
Residual              6          153.93746         25.65624

F =       3.91728       Signif F =  .0951


AIC              27.65684
PC                1.00834
CP                2.00000
SBC              27.81572


Var-Covar Matrix of Regression Coefficients (B)
Below Diagonal:  Covariance    Above:  Correlation

                MEASURE

MEASURE         .53197


XTX Matrix

                MEASURE  |     MODEL
```

```
MEASURE     1.00000  |  -.62849
MODEL        .62849  |   .60500
------------------------------------------------------------------------
Page  13                     SPSS/PC+                          10/10/91

        * * * *   M U L T I P L E   R E G R E S S I O N   * * * *

Equation Number 1    Dependent Variable..   MODEL

-------------------- Variables in the Equation --------------------

Variable            B          SE B    95% Confdnce Intrvl B      Beta

MEASURE      1.443563     .729363    -.341114     3.228240   .628487
(Constant)   5.267616    3.556251   -3.434169    13.969401

-------------------- Variables in the Equation --------------------

Variable      SE Beta   Correl Part Cor  Partial  Tolerance      VIF

MEASURE       .317544  .628487  .628487  .628487   1.000000    1.000

----------- in -----------

Variable            T  Sig T

MEASURE         1.979  .0951
(Constant)      1.481  .1891

Collinearity Diagnostics

Number  Eigenval      Cond  Variance Proportions
                     Index  Constant  MEASURE
   1     1.86395     1.000    .06802   .06802
   2      .13605     3.701    .93198   .93198

End Block Number   1   All requested variables entered.


        * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                           Summary table
                           -------------

Step  MultR    Rsq    F(Eqn)  SigF      Variable   BetaIn
  1   .6285  .3950     3.917  .095  In: MEASURE     .6285
------------------------------------------------------------------------
Page  14                     SPSS/PC+                          10/10/91

This procedure was completed at  2:34:38
get file = 'temp.sf'.
The SPSS/PC+ system file is read from
    file temp.sf
The file was created on 10/10/91 at   2:34:25
and is titled                         SPSS/PC+
The SPSS/PC+ system file contains
     40 cases, each consisting of
     6 variables (including system variables).
     6 variables will be used in this session.
------------------------------------------------------------------------
Page  15                     SPSS/PC+                          10/10/91

This procedure was completed at  2:34:39
select if ( run = 3).
CORRELATION model measure.
The raw data or transformation pass is proceeding
     8 cases are written to the compressed active file.
------------------------------------------------------------------------
Page  16                     SPSS/PC+                          10/10/91

Correlations:  MODEL      MEASURE

  MODEL       1.0000       .5461
  MEASURE      .5461      1.0000

N of cases:      8         1-tailed Signif:  * - .01  ** - .001

" . " is printed if a coefficient cannot be computed
------------------------------------------------------------------------
Page  17                     SPSS/PC+                          10/10/91

This procedure was completed at  2:34:41
regression var = model measure
   /criteria pin(.1) pout(.15)
   /statistics = all
   /dependent = model
   /method = enter measure.
------------------------------------------------------------------------
Page  18                     SPSS/PC+                          10/10/91

        * * * *   M U L T I P L E   R E G R E S S I O N   * * * *


Listwise Deletion of Missing Data

Equation Number 1    Dependent Variable..   MODEL

Block Number  1.  Method:  Enter      MEASURE


Variable(s) Entered on Step Number
   1..    MEASURE


Multiple R           .54610
R Square             .29822          R Square Change    .29822
Adjusted R Square    .18126          F Change          2.54971
Standard Error      2.12899          Signif F Change     .1614

Analysis of Variance
                        DF       Sum of Squares      Mean Square
Regression               1             11.55678         11.55678
Residual                 6             27.19553          4.53259

F =       2.54971       Signif F =  .1614


AIC              13.78889
PC                1.16963
CP                2.00000
SBC              13.94777
```

```
Var-Covar Matrix of Regression Coefficients (B)
Below Diagonal:  Covariance    Above:  Correlation

             MEASURE

MEASURE       .09398


XTX Matrix

             MEASURE        MODEL

MEASURE      1.00000      -.54610

MODEL         .54610       .70178
```

```
Page  19                        SPSS/PC+                          10/10/91

          * * * *   M U L T I P L E   R E G R E S S I O N   * * * *

Equation Number 1    Dependent Variable..   MODEL

--------------------- Variables in the Equation ----------------------

Variable              B        SE B     95% Confdnce Intrvl B       Beta

MEASURE         .489514     .306563    -.260615    1.239644     .546097
(Constant)      .857296    1.494751   -2.800209    4.514801

-------------------- Variables in the Equation ---------------------

Variable       SE Beta  Correl Part Cor  Partial  Tolerance        VIF

MEASURE        .341999  .546097  .546097  .546097   1.000000     1.000

----------- in -----------

Variable            T  Sig T

MEASURE         1.597  .1614
(Constant)       .574  .5871


Collinearity Diagnostics

Number  Eigenval     Cond  Variance Proportions
                    Index  Constant  MEASURE
   1     1.86395    1.000    .06802   .06802
   2      .13605    3.701    .93198   .93198


End Block Number   1   All requested variables entered.


          * * * * * * * * * * * * * * * * * * * * * * * * * * * * *


                           Summary table
                           -------------

Step   MultR    Rsq    F(Eqn)  SigF        Variable  BetaIn
   1   .5461  .2982     2.550  .161   In:  MEASURE    .5461
```

```
--------------------------------------------------------------------------
Page  20                        SPSS/PC+                          10/10/91

This procedure was completed at  2:34:44
get file = 'temp.sf'.
The SPSS/PC+ system file is read from
    file temp.sf
The file was created on 10/10/91 at  2:34:25
and is titled                         SPSS/PC+
The SPSS/PC+ system file contains
     40 cases, each consisting of
      6 variables (including system variables).
      6 variables will be used in this session.
--------------------------------------------------------------------------
Page  21                        SPSS/PC+                          10/10/91

This procedure was completed at  2:34:46
select if ( run = 4).
CORRELATION model measure.
The raw data or transformation pass is proceeding
      8 cases are written to the compressed active file.
--------------------------------------------------------------------------
Page  22                        SPSS/PC+                          10/10/91

Correlations:  MODEL      MEASURE

  MODEL       1.0000      .6571
  MEASURE      .6571     1.0000

N of cases:      8        1-tailed Signif:  * - .01  ** - .001

" . " is printed if a coefficient cannot be computed
--------------------------------------------------------------------------
Page  23                        SPSS/PC+                          10/10/91

This procedure was completed at  2:34:47
regression var = model measure
   /criteria pin(.1) pout(.15)
   /statistics = all
   /dependent = model
   /method = enter measure.
--------------------------------------------------------------------------
Page  24                        SPSS/PC+                          10/10/91

          * * * *   M U L T I P L E   R E G R E S S I O N   * * * *


Listwise Deletion of Missing Data

Equation Number 1    Dependent Variable..   MODEL

Block Number  1.  Method:  Enter      MEASURE


Variable(s) Entered on Step Number
   1..    MEASURE


Multiple R           .65711
R Square             .43179         R Square Change      .43179
Adjusted R Square    .33709         F Change            4.55953
Standard Error      1.47812         Signif F Change      .0766

Analysis of Variance
                        DF      Sum of Squares      Mean Square
Regression               1             9.96184          9.96184
```

```
Residual              6            13.10903          2.18484

F =        4.55953        Signif F =  .0766

AIC              7.95088
PC                .94701
CP               2.00000
SBC              8.10976

Var-Covar Matrix of Regression Coefficients (B)
Below Diagonal:  Covariance     Above:  Correlation

              MEASURE

MEASURE        .04530

XTX Matrix

              MEASURE   |      MODEL

MEASURE       1.00000   |    -.65711
------------------------+-----------
MODEL          .65711   |     .56821
------------------------------------------------------------------------
Page  25                        SPSS/PC+                        10/10/91

          * * * *   M U L T I P L E   R E G R E S S I O N   * * * *

Equation Number 1    Dependent Variable..   MODEL

--------------------- Variables in the Equation ----------------------

Variable              B        SE B     95% Confdnce Intrvl B       Beta

MEASURE          .454482    .212842    -.066320     .975284     .657110
(Constant)       .797494   1.037780   -1.741849    3.336838

-------------------- Variables in the Equation --------------------

Variable        SE Beta   Correl Part Cor  Partial  Tolerance       VIF

MEASURE         .307736  .657110  .657110  .657110  1.000000      1.000

----------- in -----------

Variable           T  Sig T

MEASURE        2.135  .0766
(Constant)      .768  .4714

Collinearity Diagnostics

Number  Eigenval    Cond   Variance Proportions
                   Index   Constant  MEASURE
   1    1.86395    1.000    .06802    .06802
   2     .13605    3.701    .93198    .93198

End Block Number   1   All requested variables entered.
```

```
          * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                          Summary table
                          -------------

Step   MultR     Rsq    F(Eqn)  Sigf       Variable  Betain
   1   .6571   .4318    4.560   .077  In:  MEASURE    .6571
------------------------------------------------------------------------
Page  26                        SPSS/PC+                        10/10/91

This procedure was completed at  2:34:51
get file = 'temp.sf'.
The SPSS/PC+ system file is read from
     file temp.sf
The file was created on 10/10/91 at  2:34:25
and is titled                          SPSS/PC+
The SPSS/PC+ system file contains
     40 cases, each consisting of
      6 variables (including system variables).
      6 variables will be used in this session.
------------------------------------------------------------------------
Page  27                        SPSS/PC+                        10/10/91

This procedure was completed at  2:34:52
select if ( run = 5).
CORRELATION model measure.
The raw data or transformation pass is proceeding
      8 cases are written to the compressed active file.
------------------------------------------------------------------------
Page  28                        SPSS/PC+                        10/10/91

Correlations:  MODEL       MEASURE

  MODEL        1.0000       .9338**
  MEASURE       .9338**    1.0000

N of cases:       8         1-tailed Signif:  * - .01   ** - .001

" . " is printed if a coefficient cannot be computed
------------------------------------------------------------------------
Page  29                        SPSS/PC+                        10/10/91

This procedure was completed at  2:34:54
regression var = model measure
   /criteria pin(.1) pout(.15)
   /statistics = all
   /dependent = model
   /method = enter measure.
------------------------------------------------------------------------
Page  30                        SPSS/PC+                        10/10/91

          * * * *   M U L T I P L E   R E G R E S S I O N   * * * *

Listwise Deletion of Missing Data

Equation Number 1    Dependent Variable..   MODEL

Block Number  1.  Method:  Enter      MEASURE

Variable(s) Entered    Step Number
```

1.. MEASURE

Multiple R	.93376		
R Square	.87191	R Square Change	.87191
Adjusted R Square	.85056	F Change	40.84041
Standard Error	1.00793	Signif F Change	.0007

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	1	41.49110	41.49110
Residual	6	6.09559	1.01593

F = 40.84041 Signif F = .0007

AIC	1.82500
PC	.21349
CP	2.00000
SBC	1.98388

Var-Covar Matrix of Regression Coefficients (B)
Below Diagonal: Covariance Above: Correlation

	MEASURE
MEASURE	.02106

XTX Matrix

	MEASURE	MODEL
MEASURE	1.00000	-.93376
MODEL	.93376	.12809

**** MULTIPLE REGRESSION ****

Equation Number 1 Dependent Variable.. MODEL

------------------ Variables in the Equation ------------------

Variable	B	SE B	95% Confdnce Intrvl B		Beta
MEASURE	.927522	.145137	.572386	1.282659	.933759
(Constant)	3.133312	.707666	1.401725	4.864898	

------------------ Variables in the Equation ------------------

Variable	SE Beta	Correl	Part Cor	Partial	Tolerance	VIF
MEASURE	.146113	.933759	.933759	.933759	1.000000	1.000

----------- in -----------

Variable	T	Sig T
MEASURE	6.391	.0007
(Constant)	4.428	.0044

Collinearity Diagnostics

Number	Eigenval	Cond Index	Variance Proportions Constant	MEASURE
1	1.86395	1.000	.06802	.06802
2	.13605	3.701	.93198	.93198

End Block Number 1 All requested variables entered.

* *

Summary table

Step	MultR	Rsq	F(Eqn)	SigF		Variable	BetaIn
1	.9338	.8719	40.840	.001	In:	MEASURE	.9338

This procedure was completed at 2:34:57
finish.

End of Include file.

ATTACHMENT 2

STATISTICAL ANALYSIS OF VALIDATION DATA PREPARED BY LIFE SYSTEMS, INC. AND REPORTED AS TABLE 1 IN APPENDIX A2 OF THE BASELINE RISK ASSESSMENT UNDER U.S. EPA CONTRACT 68-W8-0093 WORK ASSIGNMENT NO. 23-5LIZ

```
                SPSS/PC+ The Statistical Package for IBM PC               10/10/91
INC 'valid_2.prg'
*
* program to determine relationship between measured and modeled PM10
* values at CERCLA site at Ormet Plant in Hannibal, Ohio using E2M PM10
* data and the three runs presented in Table 1 of Appendix A2 of the
* Risk Assessment
*.
SET LENGTH = 59.
SET MORE = OFF.
DATA LIST /
  run 2 model 19-25 measure 27-32.
BEGIN DATA.
END DATA.
     24 cases are written to the compressed active file.

This procedure was completed at  2:43:22
save outfile = 'temp.sf'.
The SPSS/PC+ system file is written to
    file temp.sf
      6 variables (including system variables) will be saved.
      0 variables have been dropped.

The system file consists of:

         432 Characters for the header record.
         192 Characters for variable definition.
          16 Characters for labels.
        2048 Characters for data.
        2688 Total file size.

     24 out of     24 cases have been saved.

-----------------------------------------------------------------------------------
Page    2                          SPSS/PC+                                10/10/91

This procedure was completed at  2:43:23
get file = 'temp.sf'.
The SPSS/PC+ system file is read from
    file temp.sf
The file was created on 10/10/91 at  2:43:22
and is titled                          SPSS/PC+
The SPSS/PC+ system file contains
     24 cases, each consisting of
      6 variables (including system variables).
      6 variables will be used in this session.
-----------------------------------------------------------------------------------
Page    3                          SPSS/PC+                                10/10/91

This procedure was completed at  2:43:23
select if ( run = 1).
CORRELATION model measure.
The raw data or transformation pass is proceeding
      8 cases are written to the compressed active file.
-----------------------------------------------------------------------------------
Page    4                          SPSS/PC+                                10/10/91

Correlations:  MODEL      MEASURE

  MODEL       1.0000     -.8416*
  MEASURE     -.8416*    1.0000

N of cases:      8          1-tailed Signif:  * - .01  ** - .001

" . " is printed if a coefficient cannot be computed
-----------------------------------------------------------------------------------
```

```
Page    5                          SPSS/PC+                                10/10/91

This procedure was completed at  2:43:25
regression var = model measure
   /criteria pin(.1) pout(.15)
   /statistics = all
   /dependent = model
   /method = enter measure.
-----------------------------------------------------------------------------------
Page    6                          SPSS/PC+                                10/10/91

           * * * *   M U L T I P L E   R E G R E S S I O N   * * * *


Listwise Deletion of Missing Data

Equation Number 1    Dependent Variable..   MODEL

Block Number  1.  Method:  Enter      MEASURE


Variable(s) Entered on Step Number
   1..    MEASURE


Multiple R             .84160
R Square               .70829           R Square Change      .70829
Adjusted R Square      .65968           F Change           14.56863
Standard Error        6.34225           Signif F Change      .0088

Analysis of Variance
                      DF       Sum of Squares       Mean Square
Regression             1            586.00995         586.00995
Residual               6            241.34464          40.22411

F =      14.56863       Signif F =  .0088


AIC              31.25428
PC                 .48618
CP                2.00000
SBC              31.41316


Var-Covar Matrix of Regression Coefficients (B)
Below Diagonal:  Covariance    Above:  Correlation

             MEASURE

MEASURE       .83403


XTX Matrix

             MEASURE    |    MODEL

MEASURE      1.00000    |   .84160
------------------------+----------
MODEL        -.84160    |   .29171
-----------------------------------------------------------------------------------
Page    7                          SPSS/PC+                                10/10/91

           * * * *   M U L T I P L E   R E G R E S S I O N   * * * *

Equation Number 1    Dependent Variable..   MODEL
```

------------------- Variables in the Equation -------------------

Variable	B	SE B	95% Confdnce Intrvl B		Beta
MEASURE	-3.485776	.913251	-5.720409	-1.251143	-.841602
(Constant)	22.710082	4.452860	11.814384	33.605779	

------------------- Variables in the Equation -------------------

Variable	SE Beta	Correl	Part Cor	Partial	Tolerance	VIF
MEASURE	.220494	-.841602	-.841602	-.841602	1.000000	1.000

---------- in ----------

Variable	T	Sig T
MEASURE	-3.817	.0088
(Constant)	5.100	.0022

Collinearity Diagnostics

Number	Eigenval	Cond Index	Variance Proportions Constant	MEASURE
1	1.86395	1.000	.06802	.06802
2	.13605	3.701	.93198	.93198

End Block Number 1 All requested variables entered.

* *

Summary table

Step	MultR	Rsq	F(Eqn)	SigF		Variable	BetaIn
1	.8416	.7083	14.569	.009	In:	MEASURE	-.8416

Page 8 SPSS/PC+ 10/10/91

This procedure was completed at 2:43:29
get file = 'temp.sf'.
The SPSS/PC+ system file is read from
file temp.sf
The file was created on 10/10/91 at 2:43:22
and is titled SPSS/PC+
The SPSS/PC+ system file contains
24 cases, each consisting of
6 variables (including system variables).
6 variables will be used in this session.

Page 9 SPSS/PC+ 10/10/91

This procedure was completed at 2:43:30
select if (run = 2).
CORRELATION model measure.
The raw data or transformation pass is proceeding
8 cases are written to the compressed active file.

Page 10 SPSS/PC+ 10/10/91

Correlations:

	MODEL	MEASURE
MODEL	1.0000	-.8825*
MEASURE	-.8825*	1.0000

N of cases: 8 1-tailed Signif: * - .01 ** - .001

" . " is printed if a coefficient cannot be computed

Page 11 SPSS/PC+ 10/10/91

This procedure was completed at 2:43:31
regression var = model measure
/criteria pin(.1) pout(.15)
/statistics = all
/dependent = model
/method = enter measure.

Page 12 SPSS/PC+ 10/10/91

**** M U L T I P L E R E G R E S S I O N ****

Listwise Deletion of Missing Data

Equation Number 1 Dependent Variable.. MODEL

Block Number 1. Method: Enter MEASURE

Variable(s) Entered on Step Number
1.. MEASURE

Multiple R	.88250		
R Square	.77880	R Square Change	.77880
Adjusted R Square	.74193	F Change	21.12493
Standard Error	18.26630	Signif F Change	.0037

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	1	7048.49316	7048.49316
Residual	6	2001.94559	333.65760

F = 21.12493 Signif F = .0037

AIC	48.17947
PC	.36866
CP	2.00000
SBC	48.33835

Var-Covar Matrix of Regression Coefficients (B)
Below Diagonal: Covariance Above: Correlation

	MEASURE
MEASURE	6.91823

XTX Matrix

MEASURE | MODEL

Attachment 2 to EM-176-91, Page 2-3 of 4

MEASURE	1.00000	.88250
MODEL	-.88250	.22120

**** MULTIPLE REGRESSION ****

Equation Number 1 Dependent Variable.. MODEL

------------------- Variables in the Equation -------------------

Variable	B	SE B	95% Confdnce Intrvl B		Beta
MEASURE	-12.089133	2.630253	-18.525095	-5.653170	-.882497
(Constant)	81.762971	12.824675	50.382291	113.143650	

------------------- Variables in the Equation -------------------

Variable	SE Beta	Correl	Part Cor	Partial	Tolerance	VIF
MEASURE	.192006	-.882497	-.882497	-.882497	1.000000	1.000

---------- in ----------

Variable	T	Sig T
MEASURE	-4.596	.0037
(Constant)	6.375	.0007

Collinearity Diagnostics

Number	Eigenval	Cond Index	Variance Proportions Constant	MEASURE
1	1.86395	1.000	.06802	.06802
2	.13605	3.701	.93198	.93198

End Block Number 1 All requested variables entered.

* *

Summary table

Step	MultR	Rsq	F(Eqn)	SigF		Variable	BetaIn
1	.8825	.7788	21.125	.004	In:	MEASURE	-.8825


```
This procedure was completed at  2:43:35
get file = 'temp.sf'.
The SPSS/PC+ system file is read from
     file temp.sf
The file was created on 10/10/91 at  2:43:22
and is titled                        SPSS/PC+
The SPSS/PC+ system file contains
     24 cases, each consisting of
     6 variables (including system variables).
     6 variables will be used in this session.
```



```
This procedure was completed at  2:43:36
select if ( run = 3).
CORRELATION model measure.
The raw data or transformation pass is proceeding
     8 cases are written to the compressed active file.
```


Correlations: MODEL MEASURE

	MODEL	MEASURE
MODEL	1.0000	-.9036*
MEASURE	-.9036*	1.0000

N of cases: 8 1-tailed Signif: * - .01 ** - .001

" . " is printed if a coefficient cannot be computed


```
This procedure was completed at  2:43:38
regression var = model measure
   /criteria pin(.1) pout(.15)
   /statistics = all
   /dependent = model
   /method = enter measure.
```


**** MULTIPLE REGRESSION ****

Listwise Deletion of Missing Data

Equation Number 1 Dependent Variable.. MODEL

Block Number 1. Method: Enter MEASURE

Variable(s) Entered on Step Number
1.. MEASURE

Multiple R	.90362		
R Square	.81652	R Square Change	.81652
Adjusted R Square	.78594	F Change	26.70127
Standard Error	11.47748	Signif F Change	.0021

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	1	3517.42510	3517.42510
Residual	6	790.39490	131.73248

F = 26.70127 Signif F = .0021

AIC	40.74473
PC	.30580
CP	2.00000
SBC	40.90361

```
Var-Covar Matrix of Regression Coefficients (B)
Below Diagonal:  Covariance    Above:  Correlation

            MEASURE

MEASURE     2.73141


XTX Matrix

            MEASURE  |    MODEL

MEASURE     1.00000  |   .90362
---------------------+---------
MODEL       -.90362  |   .18348
---------------------------------------------------------------------------
Page  19                        SPSS/PC+                           10/10/91

         * * * *   M U L T I P L E   R E G R E S S I O N   * * * *

Equation Number 1    Dependent Variable..   MODEL

-------------------- Variables in the Equation --------------------

Variable             B        SE B    95% Confdnce Intrvl B      Beta

MEASURE      -8.540031    1.652698  -12.584015   -4.496047  -.903615
(Constant)   58.824879    8.058279   39.107087   78.542670

-------------------- Variables in the Equation --------------------

Variable      SE Beta  Correl Part Cor  Partial  Tolerance      VIF

MEASURE       .174871 -.903615 -.903615 -.903615   1.000000    1.000

----------- in ------------

Variable          T  Sig T

MEASURE      -5.167  .0021
(Constant)    7.300  .0003

Collinearity Diagnostics

Number  Eigenval     Cond  Variance Proportions
                    Index  Constant  MEASURE
    1    1.86395    1.000    .06802   .06802
    2     .13605    3.701    .93198   .93198

End Block Number   1   All requested variables entered.


         * * * * * * * * * * * * * * * * * * * * * * * * * * * * *


                           Summary table
                           -------------

Step   MultR    Rsq    F(Eqn)  SigF       Variable  BetaIn
   1   .9036  .8165    26.701  .002  In:  MEASURE   -.9036
```

```
---------------------------------------------------------------------------
Page  20                        SPSS/PC+                           10/10/91

This procedure was completed at  2:43:41
finish.

End of Include file.
```

ATTACHMENT 3

MAY 14, 1991 LETTER FROM MR. LARRY L. SIMMONS
OF ENERGY & ENVIRONMENTAL MANAGEMENT, INC. TO
MR. JOHN D. REGGI OF ORMET CORPORATION

Energy & Environmental Management, Inc.
P O Box 71, Murrysville, PA 15668-0071 (412) 733-0022 FAX (412) 733-0018

May 14, 1991 E^2M-060-91

Mr. John D. Reggi, Manager
Corporate Environmental Services
ORMET CORPORATION
P.O. Box 176
Hannibal, OH 43931

Dear John:

You requested that we provide additional information on the air dispersion analysis of PM_{10} emissions from the suspect source area. This letter responds to that request. A general procedure was outlined in the November 5, 1990 letter from Ohio EPA (OEPA) for conducting this analysis, specifically:

- On-site meteorological data were input to the Fugitive Dust Model (FDM) to assess annual PM_{10} impacts after using the 1988 PM_{10} monitoring data to develop an emissions algorithm for input to FDM.

- Results were obtained from FDM for 1989 and 1990 using the on-site meteorological data.

FDM allows the use of a wind speed dependent emission rate. It is this particular feature that makes FDM the ideal model for wind erosion impact assessment. We utilized the ten month PM_{10} data set to derive a wind speed dependent emission rate. This effort was initially undertaken using the Industrial Source Complex Short Term (ISCST) model because we were familiar with ISCST and needed to determine the general range of emission rates to expect that would give us the impacts monitored during the ten month period. Ponds 1 through 5 were segmented into 100 square meter areas as shown in Figure 1. Meteorological data from VALIDATE.BIN was run with assumed emissions from the ponds ratioed by area to Pond 5 set at 1 gram/second. We intended to determine the periods within our field data when impacts at AM-3 and AM-4 were completely unaffected by emissions from the main ORMET plant. If impacts were modeled at AM-1 or AM-2 for any hour during the day, then that day would not be considered further in developing an emission rate from the ponds. Results from this analysis are presented in Table 1. The following days during the ten month monitoring period and corresponding monitored impact are presented below:

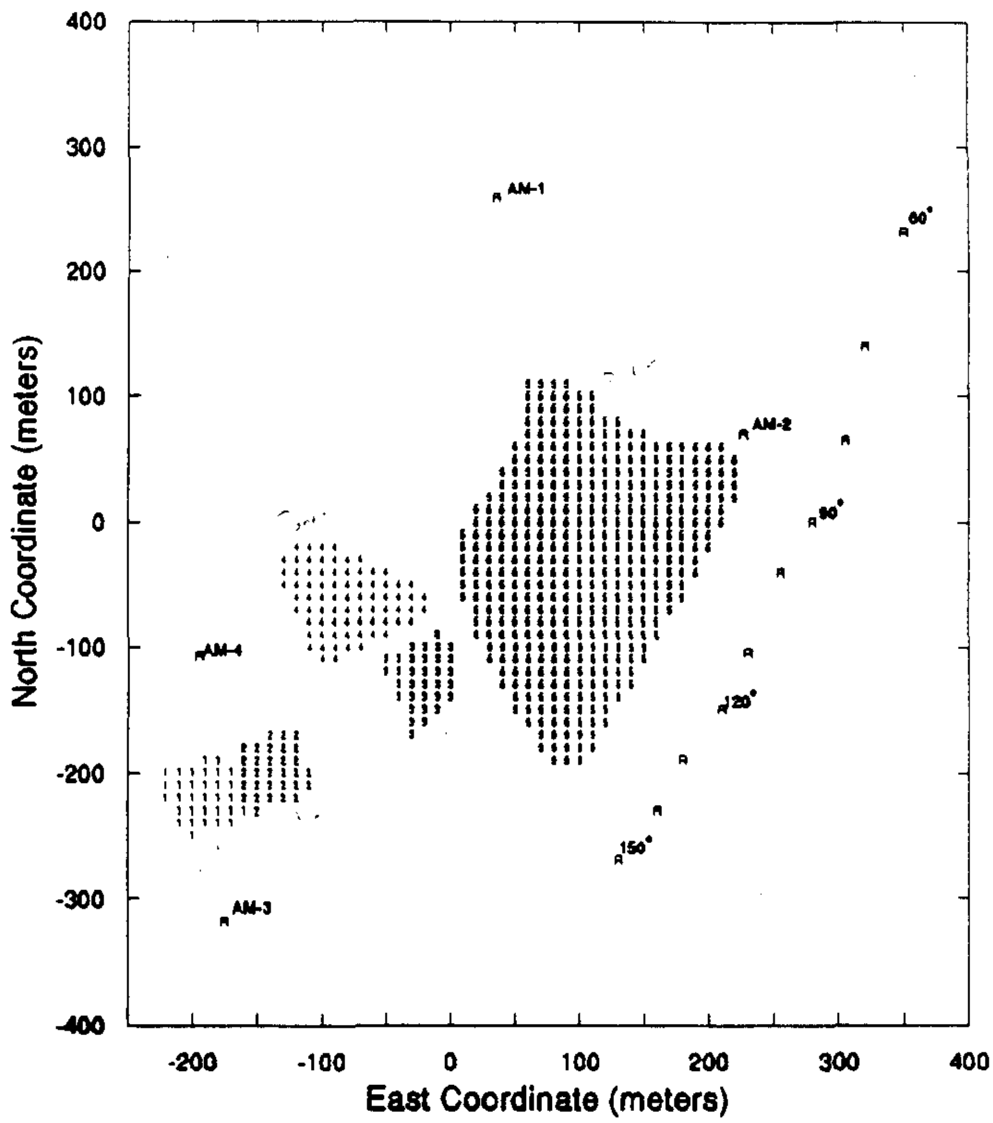


Figure 1. Pond Segment Designation, On-site PM_{10} Monitors and Eastern Property Line Receptors.

TABLE 1

PM_{10} MODELED IMPACT USING ISCST WITH ALL PONDS ARBITRARILY SET AT EMISSION RATE OF 0.0000171 GRAMS/SECOND/METER SQUARED

Date	id	PM_{10} Impact in $\mu g/m^3$			
		AM-1	AM-2	AM-3	AM-4
03/05/88	65	0.00	80.28	154.92	251.28
03/11/88	71	22.46	660.19	72.77	44.45
03/17/88	77	0.00	383.93	0.01	0.00
03/23/88	83	7.01	606.88	0.00	6.89
04/10/88	101	0.00	0.00	184.52	81.02
04/16/88	107	33.73	406.48	0.00	15.20
04/22/88	113	0.00	0.00	113.23	124.99
04/28/88	119	0.05	285.16	0.00	0.00
05/04/88	125	0.14	16.69	76.66	77.77
05/10/88	131	0.67	413.10	0.00	0.07
05/15/88	137	9.68	39.99	98.57	28.58
05/21/88	142	15.04	141.35	151.17	15.76
05/27/88	148	2.80	984.42	0.00	0.34
06/02/88	154	0.30	353.74	42.52	52.57
06/08/88	160	9.84	457.76	28.13	19.85
06/14/88	166	0.67	465.32	0.00	0.13
06/20/88	172	0.84	791.92	0.00	0.09
06/26/88	178	0.00	98.73	109.24	3.37
07/02/88	184	2.67	565.02	33.63	87.40
07/08/88	190	17.00	108.41	58.95	172.48
07/14/88	196	16.29	602.61	0.00	0.78
07/20/88	202	18.28	652.54	7.96	45.86
07/26/88	208	50.70	609.64	68.62	40.28
08/02/88	214	1.52	643.57	0.00	0.64
08/07/88	220	1.09	496.50	0.04	0.08
08/13/88	226	1.35	629.87	0.00	0.45
08/19/88	232	18.60	177.47	79.99	94.85
08/25/88	238	1.50	594.06	0.00	0.07
08/31/88	244	0.00	0.00	70.33	292.27
09/06/88	250	15.82	430.30	17.89	10.57
09/12/88	256	0.95	627.28	31.30	43.96
09/18/88	262	23.43	692.46	0.00	0.65
09/24/88	268	0.00	0.00	96.90	152.73
09/30/88	274	4.03	879.21	0.00	0.32
10/06/88	280	3.22	351.41	20.04	44.15
10/12/88	286	0.00	332.52	0.00	0.00
10/18/88	292	0.24	267.33	0.00	0.00
10/24/88	298	1.76	387.96	0.00	0.01
10/30/88	304	0.29	4.82	54.98	153.27
11/05/88	310	71.38	176.14	00.00	73.25
11/11/88	316	14.57	465.61	2.40	133.75
11/17/88	322	0.00	767.11	0.00	0.00
11/23/88	328	0.00	0.00	61.66	416.60
11/29/88	334	10.03	753.43	0.00	6.32
12/05/88	340	7.77	748.36	0.00	0.53
12/11/88	346	0.00	96.11	72.21	11.20
12/17/88	352	2.58	480.89	0.00	0.00
12/23/88	358	5.08	825.65	0.00	0.00
12/29/88	364	1.59	894.16	0.00	0.00

Date	Downwind-Upwind ($\mu g/m^3$) AM-3	AM-4
04/10/88	6.6	6.0
04/22/88	2.0	4.9
08/31/88	0.2	7.3
09/24/88	1.5	5.2
11/23/88	---	20.3

The data for 11/23/88 were not complete for AM-3 and AM-4, so that day was not considered further.

We now have a target validation period (4 days) with downwind - minus upwind PM_{10} values. The four (4) days were selected from the VALIDATE.BIN file for FDM impact assessment. Emissions from Ponds 4 and 5 were considered for this analysis. Telephone discussions with agency personnel and their contractors focused on emissions from only Pond 5. However, the silt analyses presented from Geraghty & Miller's field test in November, 1990 show Pond 4 at several times the silt content of the other ponds. We felt that Pond 4 emissions could not be ignored because of the high silt value.

A series of model runs was made with FDM at various emission rates. Table 2 presents a summary of those runs. The purpose of the computer runs presented in Table 2 is to develop a wind speed dependent emission rate that could be used for estimating 1989 and 1990 impacts. After several iterations, we determined that separate emission rates were not needed for Ponds 4 and 5. A final emission rate below was determined by our analysis:

$$E.R. = 3.32E\text{-}7 \cdot (WS)^{2.8617} \qquad \text{Eq. 1}$$

Where: E.R. = Emission Rate in grams/second/square meter,
WS = Wind speed at 10 meters in meters/second.

Equation 1 yields an average over-prediction at AM-3 of 112 percent and at AM-4 of 47 percent. While the over-prediction at AM-3 is probably related to over-estimation of Pond 5 emissions with respect to Pond 4 emissions, we did not have time to further adjust the wind speed dependent emission equation. Over-predictions at AM-3 will likely carry over to modeled over predictions at the sites nearest Pond 5 (i.e., AM-2 and eastern property line). Output from Run 5 is presented in Attachment 1.

TABLE 2

PM_{10} 24-HOUR IMPACTS AT AM-3 AND AM-4 USING FDM
UNDER VARYING EMISSION RATES AND FOR SELECTED
DAYS FROM TEN MONTH PM_{10} FIELD DATA

		PM_{10} Values in $\mu g/m^3$			
		AM-3		AM-4	
Run*	Date	Model	Measured**	Model	Measured**
1	04/10	2.217	6.6	1.302	6.0
	04/22	1.183	2.0	1.638	4.9
	08/31	0.458	0.2	1.025	7.3
	09/24	0.467	1.5	0.745	5.2
2	04/10	22.259	6.6	13.098	6.0
	04/22	11.875	2.0	16.471	4.9
	08/31	4.609	0.2	10.301	7.3
	09/24	4.681	1.5	7.495	5.2
3	04/10	7.363	6.6	4.511	6.0
	04/22	2.822	2.0	4.366	4.9
	08/31	0.887	0.2	1.782	7.3
	09/24	0.632	1.5	0.992	5.2
4	04/10	5.132	6.6	4.624	6.0
	04/22	2.207	2.0	4.623	4.9
	08/31	0.788	0.2	2.182	7.3
	09/24	0.6976	1.5	1.442	5.2
5	04/10	8.997	6.6	6.939	6.0
	04/22	5.810	2.0	8.849	4.9
	08/31	3.080	0.2	10.620	7.3
	09/24	3.970	1.5	8.059	5.2

* Run 1 Pond 4 Emissions = 4.23 E-9 (WS ** 5.464).
Run 1 Pond 5 Emissions = 5.72 E-9 (WS ** 5.7189).
Run 2 Pond 4 Emissions = 4.23 E-8 (WS ** 5.464).
Run 2 Pond 5 Emissions = 5.72 E-8 (WS ** 5.7189).
Run 3 Pond 4 Emissions = 8.16 E-10 (WS ** 7.9329).
Run 3 Pond 5 Emissions = 1.10 E-9 (WS ** 8.1876).
Run 4 Pond 4 Emissions = 3.05 E-9 (WS ** 7.0820).
Run 4 Pond 5 Emissions = 3.89 E-9 (WS ** 6.6890).
Run 5 Pond 4 & 5 Emissions = 3.32 E-7 (WS ** 2.8617).
** Measured is downwind minus upwind.

An additional test was undertaken to ascertain if FDM is sensitive to the segmentation of the source, i.e., if we break the source into smaller segments, will we see a difference in modeled impact at a receptor. We tested this question by representing Ponds 4 and 5 as 482 small sources (100 square meters each) versus the 80 source segmentation used for the impacts in Table 2. A comparison of the modeled impacts is listed below:

	AM-3 ($\mu g/m^3$)		AM-4 ($\mu g/m^3$)	
Date	482	80	482	80
04/10	7.531	8.997	6.230	6.939
04/22	4.782	5.810	8.000	8.849
08/31	2.566	3.080	9.446	10.620
09/24	3.280	3.970	7.243	8.059

The fewer the number of source segments, the higher the modeled impacts. Final impact assessments presented in this letter were prepared using an 80 source segmentation representation for Ponds 4 and 5. The closer the modeling receptor is to the sources, the more pronounced the difference in impact by degree of segmentation. The 80 source segmentation used for our analysis was developed using the ISCST User's Manual for source size to receptor distances of 1 to 3, where possible, for the ORMET property line. We will have some bias at AM-1, AM-2, AM-3 and AM-4 because these sites generally are closer to Ponds 4 or 5 than the property line.

With a final emission rate developed, we then conducted the PM_{10} annual impact assessment for 1989 and 1990. Attachments 2 and 3 present 1989 and 1990 FDM output for the on-site PM_{10} monitors used during the ten month monitoring program. Attachments 4 and 5 present 1989 and 1990 FDM output for the receptors in Proctor, West Virginia. Table 3 presents the 1989 and 1990 modeled PM_{10} impacts at the property line. Figure 2 presents the location of the property line receptors and Proctor, West Virginia receptors. Table 4 presents a summary listing of the output data presented in Attachments 2 through 5.

Maximum annual impacts at the property line are 7.66 $\mu g/m^3$. Similarly, across the Ohio River, in Proctor, West Virginia the maximum annual impact is 0.83 $\mu g/m^3$. Property line impacts may be slightly higher than if we significantly increased the segment number for Ponds 4 and 5 and remodeled. Maximum annual impacts at AM-2 of 23.47 $\mu g/m^3$ would decrease by at least 10 percent if we went from an 80 source segmentation to 482 source segmentation used in the test cases to develop an emission factor.

TABLE 3

ANNUAL PM_{10} IMPACTS AT THE ORMET PROPERTY LINE
USING THE FUGITIVE DUST MODEL (FDM)

Modeling Receptors	Coordinate (m)* East	Coordinate (m)* North	Impact (lg/m^3) 1989	Impact (lg/m^3) 1990
10 degrees	68	394	0.26431	0.26481
20 degrees	168	462	0.48444	0.47028
30 degrees	363	636	0.65878	0.63298
40 degrees	373	384	1.96980	1.97869
50 degrees	357	294	2.89597	2.98955
60 degrees	336	200	4.54204	4.80380
70 degrees	315	116	6.67873	7.11835
80 degrees	300	53	7.26297	7.65701
90 degrees	279	0	6.85423	7.17535
100 degrees	263	-47	5.63609	5.81224
110 degrees	247	-84	4.65932	4.71709
120 degrees	226	-126	3.52218	3.46213
130 degrees	205	-173	2.23896	2.10823
140 degrees	184	-215	1.48041	1.30520
150 degrees	152	-268	0.86407	0.63927
160 degrees	116	-336	0.48605	0.31027
170 degrees	63	-389	0.34313	0.20770
180 degrees	0	-457	0.23764	0.14628
190 degrees	-95	-520	0.17748	0.12426
200 degrees	-221	-594	0.13302	0.11321
210 degrees	-405	-725	0.09059	0.09200
220 degrees	-720	-851	0.07249	0.08569
230 degrees	-993	-830	0.08338	0.09645
240 degrees	-1067	-631	0.10764	0.11984
250 degrees	-1146	-415	0.07461	0.08455
260 degrees	-1025	-173	0.03620	0.05495
270 degrees	-751	0	0.02956	0.04345
280 degrees	-610	95	0.02996	0.03150
290 degrees	-420	152	0.04713	0.03232
300 degrees	-331	184	0.05751	0.03339
310 degrees	-257	215	0.06399	0.03612
320 degrees	-205	236	0.06854	0.04111
330 degrees	-152	263	0.07206	0.05035
340 degrees	-100	289	0.08438	0.07009
350 degrees	-53	315	0.11287	0.10586
360 degrees	0	342	0.17272	0.17264

* East and North coordinates in meters (Monitoring Well MW-17 as 0,0).

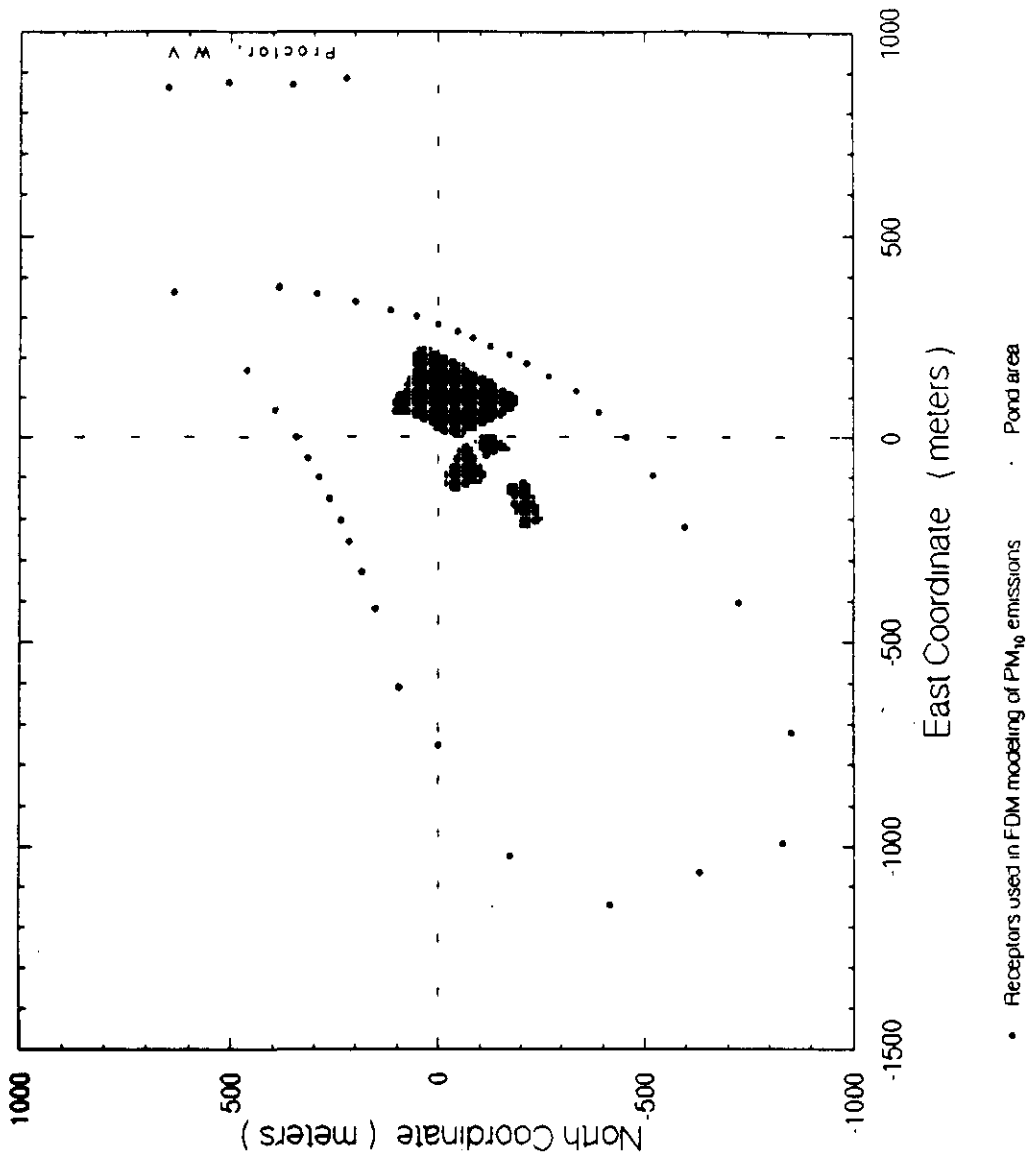


Figure 2. Property Line and Proctor, West Virginia Receptors.

TABLE 4

ANNUAL PM_{10} IMPACTS AT THE MONITORING SITES AND AT PROCTOR, WEST VIRGINIA USING THE FUGITIVE DUST MODEL (FDM)

Modeling Receptors	Coordinate (m)*		Impact (lg/m^3)	
	East	North	1989	1990
AM-1	35	258	0.475	0.466
AM-2	227	70	22.633	23.474
AM-3	-176	-318	0.496	0.530
AM-4	-195	-108	1.173	1.371
Proctor, WV #1	864	651	0.623	0.681
Proctor, WV #2	875	505	0.698	0.776
Proctor, WV #3	870	351	0.771	0.831
Proctor, WV #4	886	222	0.665	0.684

* East and North coordinates in meters (Monitoring Well MW-17 as 0,0).

Four (4) floppy disks are enclosed which contain the input FDM files we used to create Attachments 1 through 5. Output files are also included on the diskette. If you have any questions about this analysis, please give me a call.

Sincerely,

Larry L. Simmons, P.E.
Principal

LLS/das

CC: Frank Jones - G&M
L.E. Lambert - E^2M
C-312

ATTACHMENT 1

FDM OUTPUT FROM RUN 5

```
1

                FUGITIVE DUST MODEL (FDM)
                VERSION 91070
                MAR, 1991


    RUN TITLE:
        pond 4 & 5 tests to develop final emissions

        INPUT FILE NAME: test.dat
        OUTPUT FILE NAME: test.out
        MET DATA READ FROM FILE NAME: validate.bin
        PLOT OUTPUT WRITTEN TO FILE NAME: test.plt
        POST-PROCESSOR OUTPUT WRITTEN TO FILE NAME: test.bin


        CONVERGENCE OPTION 1=OFF, 2=ON                     1
        MET OPTION SWITCH, 1=CARDS, 2=PREPROCESSED         2
        PLOT FILE OUTPUT, 1=NO, 2=YES                      2
        MET DATA PRINT SWITCH, 1=NO, 2=YES                 1
        POST-PROCESSOR OUTPUT, 1=NO, 2=YES                 2
        DEP. VEL./GRAV. SETL. VEL., 1=DEFAULT, 2=USER      1
        PRINT 1-HOUR AVERAGE CONCEN, 1=NO, 2=YES           1
        PRINT 3-HOUR AVERAGE CONCEN, 1=NO, 2=YES           1
        PRINT 8-HOUR AVERAGE CONCEN, 1=NO, 2=YES           1
        PRINT 24-HOUR AVERAGE CONCEN, 1=NO, 2=YES          2
        PRINT LONG-TERM AVERAGE CONCEN, 1=NO, 2=YES        1
        BYPASS RAMMET CALMS RECOGNITION, 1=NO, 2=YES       0
        NUMBER OF SOURCES PROCESSED                       80
        NUMBER OF RECEPTORS PROCESSED                      4
        NUMBER OF PARTICLE SIZE CLASSES                    0
        NUMBER OF HOURS OF MET DATA PROCESSED             96
        LENGTH IN MINUTES OF 1-HOUR OF MET DATA          60.
        ROUGHNESS LENGTH IN CM                        100.00
        SCALING FACTOR FOR SOURCE AND RECPTORS        1.0000
        PARTICLE DENSITY IN G/CM**3                     2.00
        ANEMOMETER HEIGHT IN M                         10.00

        PREPROCESSED METEOROLOGICAL DATA SELECTION SWITCHES
        00000000000000000000000000000000000000000000000000000000000000000000000000000000
        00000000000000000000100000000000100000000000000000000000000000000000000000000000
        00000000000000000000000000000000000000000000000000000000000000000000000000000000
        00010000000000000000000000010000000000000000000000000000000000000000000000000000
        0000000000000000000000000000000000000000000000
1

        RECEPTOR COORDINATES (X,Y,Z)

(   35.,    258.,  2.) (   227.,     70.,  2.) (  -176.,   -318.,  2.)
(  -195.,   -108.,  4.) (
1

        SOURCE INFORMATION

             ENTERED EMIS.    TOTAL
              RATE (G/SEC,  EMISSION   WIND
              G/SEC/M OR       RATE   SPEED      X1       Y1      X2       Y2  HEIGHT   WIDTH
        TYPE  G/SEC/M**2)   (G/SEC)    FAC.     (M)      (M)     (M)      (M)     (M)     (M)
        ---- -------------- --------- ------ ------- -------- ------- -------- ------- -------
          3    0.000000332   0.00030  2.862    -25.     -55.     30.      30.    0.50    0.00
          3    0.000000332   0.00030  2.862    -55.     -55.     30.      30.    0.50    0.00
```

3	0.000000332	0.00030	2.862	-85.	-55.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	-115.	-70.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-90.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-110.	-50.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-70.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-70.	-100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-130.	-30.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	-105.	-25.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	-75.	-25.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	-50.	-30.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-50.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-30.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00003	2.862	65.	85.	10.	10.	0.50	0.00
3	0.000000332	0.00013	2.862	170.	70.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	145.	85.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	115.	85.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	85.	75.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	60.	70.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	100.	100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	80.	100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	60.	100.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	165.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	165.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	60.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	40.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	20.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	60.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	40.	20.	20.	0.50	0.00
3	0.000000332	0.00003	2.862	225.	55.	10.	10.	0.50	0.00
3	0.000000332	0.00003	2.862	225.	45.	10.	10.	0.50	0.00
3	0.000000332	0.00003	2.862	225.	35.	10.	10.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	20.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	00.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	00.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	-20.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	165.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	180.	-40.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	160.	-40.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-10.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-30.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-50.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	45:	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-70.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-75.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-75.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-105.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-105.	30.	30.	0.50	0.00

```
            3    0.000000332    0.00030  2.862   105.    -75.    30.    30.   0.50   0.00
            3    0.000000332    0.00030  2.862   105.   -105.    30.    30.   0.50   0.00
            3    0.000000332    0.00013  2.862   160.    -60.    20.    20.   0.50   0.00
            3    0.000000332    0.00030  2.862   135.    -75.    30.    30.   0.50   0.00
            3    0.000000332    0.00030  2.862   135.   -105.    30.    30.   0.50   0.00
            3    0.000000332    0.00030  2.862    55.   -135.    30.    30.   0.50   0.00
            3    0.000000332    0.00030  2.862    85.   -135.    30.    30.   0.50   0.00
            3    0.000000332    0.00030  2.862   115.   -135.    30.    30.   0.50   0.00
            3    0.000000332    0.00013  2.862    80.   -160.    20.    20.   0.50   0.00
            3    0.000000332    0.00013  2.862   100.   -160.    20.    20.   0.50   0.00
            3    0.000000332    0.00013  2.862   180.    -60.    20.    20.   0.50   0.00
            3    0.000000332    0.00013  2.862   160.    -70.    20.    20.   0.50   0.00
            3    0.000000332    0.00013  2.862   160.   -100.    20.    20.   0.50   0.00
            3    0.000000332    0.00013  2.862   140.   -130.    20.    20.   0.50   0.00
            3    0.000000332    0.00013  2.862   120.   -160.    20.    20.   0.50   0.00
            3    0.000000332    0.00030  2.862    95.   -185.    30.    30.   0.50   0.00
                              ==========
         TOTAL EMISSIONS        0.01670
         NOTE:  SOME SOURCE EMISSION RATES ARE A FUNCTION OF WIND SPEED AND TOTAL IS NOT CORRECT
1
            24 HOUR AVERAGE FOR HOUR ENDING    24
                   CONCENTRATIONS IN MICROGRAMS/M**3

 (    35.,    258.,      0.000)  (   227.,     70.,      0.000)  (  -176.,   -318.,      8.997)
 (  -195.,   -108.,      6.939)  (
1
            24 HOUR AVERAGE FOR HOUR ENDING    24
                   DEPOSITION RATE IN MICROGRAMS/M**2/SEC

 (    35.,    258.,**********)  (   227.,     70.,**********)  (  -176.,   -318.,**********)
 (  -195.,   -108.,**********)  (
****** NOTE: FOR RECEPTORS WITH Z UNEQUAL 0, DEPOSITION IS SET TO 999999.999
1
            24 HOUR AVERAGE FOR HOUR ENDING    48
                   CONCENTRATIONS IN MICROGRAMS/M**3

 (    35.,    258.,      0.003)  (   227.,     70.,      0.000)  (  -176.,   -318.,      5.810)
 (  -195.,   -108.,      8.849)  (
1
            24 HOUR AVERAGE FOR HOUR ENDING    48
                   DEPOSITION RATE IN MICROGRAMS/M**2/SEC

 (    35.,    258.,**********)  (   227.,     70.,**********)  (  -176.,   -318.,**********)
 (  -195.,   -108.,**********)  (
****** NOTE: FOR RECEPTORS WITH Z UNEQUAL 0, DEPOSITION IS SET TO 999999.999
1
            24 HOUR AVERAGE FOR HOUR ENDING    72
                   CONCENTRATIONS IN MICROGRAMS/M**3

 (    35.,    258.,      0.000)  (   227.,     70.,      0.000)  (  -176.,   -318.,      3.080)
 (  -195.,   -108.,     10.620)  (
1
            24 HOUR AVERAGE FOR HOUR ENDING    72
                   DEPOSITION RATE IN MICROGRAMS/M**2/SEC

 (    35.,    258.,**********)  (   227.,     70.,**********)  (  -176.,   -318.,**********)
 (  -195.,   -108.,**********)  (
****** NOTE: FOR RECEPTORS WITH Z UNEQUAL 0, DEPOSITION IS SET TO 999999.999
1
            24 HOUR AVERAGE FOR HOUR ENDING    96
                   CONCENTRATIONS IN MICROGRAMS/M**3
```

```
(    35.,     258.,       0.000) (   227.,      70.,       0.000) (  -176.,    -318.,       3.970)
(  -195.,    -108.,       8.059) (
1
          24 HOUR AVERAGE FOR HOUR ENDING    96
                DEPOSITION RATE IN MICROGRAMS/M**2/SEC

(    35.,     258.,**********) (   227.,      70.,**********) (  -176.,    -318.,**********)
(  -195.,    -108.,**********) (
****** NOTE: FOR RECEPTORS WITH Z UNEQUAL 0, DEPOSITION IS SET TO 999999.999
```

ATTACHMENT 2

ANNUAL PM_{10} IMPACTS AT RECEPTORS AM-1,
AM-2, AM-3 AND AM-4 IN 1989

1

```
            FUGITIVE DUST MODEL (FDM)
            VERSION 91070
            MAR, 1991

 RUN TITLE:
     pond 4 & 5 calibrated emit --  80 src

     INPUT FILE NAME: monitor.dat
     OUTPUT FILE NAME: 89a.out
     MET DATA READ FROM FILE NAME: ormet_89.bin
     PLOT OUTPUT WRITTEN TO FILE NAME: 89a.plt


     CONVERGENCE OPTION 1=OFF, 2=ON                    1
     MET OPTION SWITCH, 1=CARDS, 2=PREPROCESSED        2
     PLOT FILE OUTPUT, 1=NO, 2=YES                     2
     MET DATA PRINT SWITCH, 1=NO, 2=YES                1
     POST-PROCESSOR OUTPUT, 1=NO, 2=YES                1
     DEP. VEL./GRAV. SETL. VEL., 1=DEFAULT, 2=USER     1
     PRINT 1-HOUR AVERAGE CONCEN, 1=NO, 2=YES          1
     PRINT 3-HOUR AVERAGE CONCEN, 1=NO, 2=YES          1
     PRINT 8-HOUR AVERAGE CONCEN, 1=NO, 2=YES          1
     PRINT 24-HOUR AVERAGE CONCEN, 1=NO, 2=YES         1
     PRINT LONG-TERM AVERAGE CONCEN, 1=NO, 2=YES       2
     BYPASS RAMMET CALMS RECOGNITION, 1=NO, 2=YES      0
     NUMBER OF SOURCES PROCESSED                      80
     NUMBER OF RECEPTORS PROCESSED                     4
     NUMBER OF PARTICLE SIZE CLASSES                   0
     NUMBER OF HOURS OF MET DATA PROCESSED          8760
     LENGTH IN MINUTES OF 1-HOUR OF MET DATA         60.
     ROUGHNESS LENGTH IN CM                       100.00
     SCALING FACTOR FOR SOURCE AND RECPTORS       1.0000
     PARTICLE DENSITY IN G/CM**3                    2.00
     ANEMOMETER HEIGHT IN M                        10.00

     PREPROCESSED METEOROLOGICAL DATA SELECTION SWITCHES
     11111111111111111111111111111111111111111111111111111111111111111111111111111111
     11111111111111111111111111111111111111111111111111111111111111111111111111111111
     11111111111111111111111111111111111111111111111111111111111111111111111111111111
     11111111111111111111111111111111111111111111111111111111111111111111111111111111
     1111111111111111111111111111111111111111111110
1

     RECEPTOR COORDINATES (X,Y,Z)

(   35.,    258.,  2.) (   227.,     70.,  2.) (  -176.,   -318.,  2.)
(  -195.,   -108.,  4.) (
1

     SOURCE INFORMATION
```

TYPE	ENTERED EMIS. RATE (G/SEC, G/SEC/M OR G/SEC/M**2)	TOTAL EMISSION RATE (G/SEC)	WIND SPEED FAC.	X1 (M)	Y1 (M)	X2 (M)	Y2 (M)	HEIGHT (M)	WIDTH (M)
3	0.000000332	0.00030	2.862	-25.	-55.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	-55.	-55.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	-85.	-55.	30.	30.	0.50	0.00

3	0.000000332	0.00013	2.862	-115.	-70.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-90.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-110.	-50.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-70.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-70.	-100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-130.	-30.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	-105.	-25.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	-75.	-25.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	-50.	-30.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-50.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-30.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00003	2.862	65.	85.	10.	10.	0.50	0.00
3	0.000000332	0.00013	2.862	170.	70.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	145.	85.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	115.	85.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	85.	75.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	60.	70.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	100.	100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	80.	100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	60.	100.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	165.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	165.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	60.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	40.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	20.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	60.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	40.	20.	20.	0.50	0.00
3	0.000000332	0.00003	2.862	225.	55.	10.	10.	0.50	0.00
3	0.000000332	0.00003	2.862	225.	45.	10.	10.	0.50	0.00
3	0.000000332	0.00003	2.862	225.	35.	10.	10.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	20.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	00.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	00.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	-20.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	165.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	180.	-40.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	160.	-40.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-10.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-30.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-50.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75:	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-70.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-75.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-75.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-105.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-105.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	-75.	30.	30.	0.50	0.00

3	0.000000332	0.00030	2.862	105.	-105.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	160.	-60.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-75.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-105.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	55.	-135.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	85.	-135.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	115.	-135.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	80.	-160.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	100.	-160.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	180.	-60.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	160.	-70.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	160.	-100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	140.	-130.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	120.	-160.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	95.	-185.	30.	30.	0.50	0.00

```
                              ==========
TOTAL EMISSIONS               0.01670
NOTE:  SOME SOURCE EMISSION RATES ARE A FUNCTION OF WIND SPEED AND TOTAL IS NOT CORRECT
1
         8760 HOUR AVERAGE FOR HOUR ENDING  8760
                CONCENTRATIONS IN MICROGRAMS/M**3

(    35.,    258.,     0.475) (   227.,     70.,    22.633) (  -176.,   -318.,     0.496)
(  -195.,   -108.,     1.173) (
1
         8760 HOUR AVERAGE FOR HOUR ENDING  8760
                DEPOSITION RATE IN MICROGRAMS/M**2/SEC

(    35.,    258.,**********) (   227.,     70.,**********) (  -176.,   -318.,**********)
(  -195.,   -108.,**********) (
****** NOTE: FOR RECEPTORS WITH Z UNEQUAL 0, DEPOSITION IS SET TO 999999.999
95.   -185.    30.    30.    0.50    0.00
```

ATTACHMENT 3

ANNUAL PM_{10} IMPACTS AT RECEPTORS AM-1,
AM-2, AM-3 AND AM-4 IN 1990

1

FUGITIVE DUST MODEL (FDM)
VERSION 91070
MAR, 1991

RUN TITLE:
pond 4 & 5 calibrated emit -- 80 src

INPUT FILE NAME: monitor.dat
OUTPUT FILE NAME: 90a.out
MET DATA READ FROM FILE NAME: ormet_90.bin
PLOT OUTPUT WRITTEN TO FILE NAME: 90a.plt

CONVERGENCE OPTION 1=OFF, 2=ON	1
MET OPTION SWITCH, 1=CARDS, 2=PREPROCESSED	2
PLOT FILE OUTPUT, 1=NO, 2=YES	2
MET DATA PRINT SWITCH, 1=NO, 2=YES	1
POST-PROCESSOR OUTPUT, 1=NO, 2=YES	1
DEP. VEL./GRAV. SETL. VEL., 1=DEFAULT, 2=USER	1
PRINT 1-HOUR AVERAGE CONCEN, 1=NO, 2=YES	1
PRINT 3-HOUR AVERAGE CONCEN, 1=NO, 2=YES	1
PRINT 8-HOUR AVERAGE CONCEN, 1=NO, 2=YES	1
PRINT 24-HOUR AVERAGE CONCEN, 1=NO, 2=YES	1
PRINT LONG-TERM AVERAGE CONCEN, 1=NO, 2=YES	2
BYPASS RAMMET CALMS RECOGNITION, 1=NO, 2=YES	0
NUMBER OF SOURCES PROCESSED	80
NUMBER OF RECEPTORS PROCESSED	4
NUMBER OF PARTICLE SIZE CLASSES	0
NUMBER OF HOURS OF MET DATA PROCESSED	8760
LENGTH IN MINUTES OF 1-HOUR OF MET DATA	60.
ROUGHNESS LENGTH IN CM	100.00
SCALING FACTOR FOR SOURCE AND RECPTORS	1.0000
PARTICLE DENSITY IN G/CM**3	2.00
ANEMOMETER HEIGHT IN M	10.00

PREPROCESSED METEOROLOGICAL DATA SELECTION SWITCHES
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11111111111111111111111111111111111111111111111111111111111111111111111111111111
1111111111111111111111111111111111111111111110

1

RECEPTOR COORDINATES (X,Y,Z)

(35., 258., 2.) (227., 70., 2.) (-176., -318., 2.)
(-195., -108., 4.) (

1

SOURCE INFORMATION

TYPE	ENTERED EMIS. RATE (G/SEC, G/SEC/M OR G/SEC/M**2)	TOTAL EMISSION RATE (G/SEC)	WIND SPEED FAC.	X1 (M)	Y1 (M)	X2 (M)	Y2 (M)	HEIGHT (M)	WIDTH (M)
3	0.000000332	0.00030	2.862	-25.	-55.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	-55.	-55.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	-85.	-55.	30.	30.	0.50	0.00

3	0.000000332	0.00013	2.862	-115.	-70.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-90.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-110.	-50.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-70.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-70.	-100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-130.	-30.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	-105.	-25.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	-75.	-25.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	-50.	-30.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-50.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-30.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00003	2.862	65.	85.	10.	10.	0.50	0.00
3	0.000000332	0.00013	2.862	170.	70.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	145.	85.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	115.	85.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	85.	75.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	60.	70.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	100.	100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	80.	100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	60.	100.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	165.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	165.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	60.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	40.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	20.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	60.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	40.	20.	20.	0.50	0.00
3	0.000000332	0.00003	2.862	225.	55.	10.	10.	0.50	0.00
3	0.000000332	0.00003	2.862	225.	45.	10.	10.	0.50	0.00
3	0.000000332	0.00003	2.862	225.	35.	10.	10.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	20.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	00.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	00.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	-20.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	165.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	180.	-40.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	160.	-40.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-10.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-30.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-50.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-70.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-75.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-75.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-105.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-105.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	-75.	30.	30.	0.50	0.00

3	0.000000332	0.00030	2.862	105.	-105.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	160.	-60.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-75.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-105.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	55.	-135.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	85.	-135.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	115.	-135.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	80.	-160.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	100.	-160.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	180.	-60.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	160.	-70.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	160.	-100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	140.	-130.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	120.	-160.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	95.	-185.	30.	30.	0.50	0.00

===========

TOTAL EMISSIONS 0.01670

NOTE: SOME SOURCE EMISSION RATES ARE A FUNCTION OF WIND SPEED AND TOTAL IS NOT CORRECT

1

8760 HOUR AVERAGE FOR HOUR ENDING 8760
CONCENTRATIONS IN MICROGRAMS/M**3

(35., 258., 0.466) (227., 70., 23.474) (-176., -318., 0.530)
(-195., -108., 1.371) (

1

8760 HOUR AVERAGE FOR HOUR ENDING 8760
DEPOSITION RATE IN MICROGRAMS/M**2/SEC

(35., 258.,**********) (227., 70.,**********) (-176., -318.,**********)
(-195., -108.,**********) (

****** NOTE: FOR RECEPTORS WITH Z UNEQUAL 0, DEPOSITION IS SET TO 999999.999

95. -185. 30. 30. 0.50 0.00

ATTACHMENT 4

ANNUAL PM_{10} IMPACTS IN 1989 AT FOUR RECEPTORS
ALONG THE PIPELINE SEPARATING PROCTOR,
WEST VIRGINIA FROM THE OHIO RIVER

1

FUGITIVE DUST MODEL (FDM)
VERSION 91070
MAR, 1991

RUN TITLE:
ponds 4 & 5 Annual Impacts at Proctor, WV

INPUT FILE NAME: proctor.dat
OUTPUT FILE NAME: 89b.out
MET DATA READ FROM FILE NAME: ormet_89.bin
PLOT OUTPUT WRITTEN TO FILE NAME: 89b.plt

CONVERGENCE OPTION 1=OFF, 2=ON	1
MET OPTION SWITCH, 1=CARDS, 2=PREPROCESSED	2
PLOT FILE OUTPUT, 1=NO, 2=YES	2
MET DATA PRINT SWITCH, 1=NO, 2=YES	1
POST-PROCESSOR OUTPUT, 1=NO, 2=YES	1
DEP. VEL./GRAV. SETL. VEL., 1=DEFAULT, 2=USER	1
PRINT 1-HOUR AVERAGE CONCEN, 1=NO, 2=YES	1
PRINT 3-HOUR AVERAGE CONCEN, 1=NO, 2=YES	1
PRINT 8-HOUR AVERAGE CONCEN, 1=NO, 2=YES	1
PRINT 24-HOUR AVERAGE CONCEN, 1=NO, 2=YES	1
PRINT LONG-TERM AVERAGE CONCEN, 1=NO, 2=YES	2
BYPASS RAMMET CALMS RECOGNITION, 1=NO, 2=YES	0
NUMBER OF SOURCES PROCESSED	80
NUMBER OF RECEPTORS PROCESSED	4
NUMBER OF PARTICLE SIZE CLASSES	0
NUMBER OF HOURS OF MET DATA PROCESSED	8760
LENGTH IN MINUTES OF 1-HOUR OF MET DATA	60.
ROUGHNESS LENGTH IN CM	100.00
SCALING FACTOR FOR SOURCE AND RECPTORS	1.0000
PARTICLE DENSITY IN G/CM**3	2.00
ANEMOMETER HEIGHT IN M	10.00

PREPROCESSED METEOROLOGICAL DATA SELECTION SWITCHES
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11111111111111111111111111111111111111111111111111111111111111111111111111111111
111111111111111111111111111111111111111111111110

1

RECEPTOR COORDINATES (X,Y,Z)

(864., 651., 00.) (875., 505., 00.) (870., 351., 00.)
(886., 222., 00.) (

1

SOURCE INFORMATION

TYPE	ENTERED EMIS. RATE (G/SEC, G/SEC/M OR G/SEC/M**2)	TOTAL EMISSION RATE (G/SEC)	WIND SPEED FAC.	X1 (M)	Y1 (M)	X2 (M)	Y2 (M)	HEIGHT (M)	WIDTH (M)
3	0.000000332	0.00030	2.862	-25.	-55.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	-55.	-55.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	-85.	-55.	30.	30.	0.50	0.00

3	0.000000332	0.00013	2.862	-115.	-70.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-90.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-110.	-50.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-70.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-70.	-100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-130.	-30.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	-105.	-25.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	-75.	-25.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	-50.	-30.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-50.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-30.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00003	2.862	65.	85.	10.	10.	0.50	0.00
3	0.000000332	0.00013	2.862	170.	70.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	145.	85.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	115.	85.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	85.	75.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	60.	70.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	100.	100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	80.	100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	60.	100.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	165.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	165.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	60.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	40.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	20.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	60.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	40.	20.	20.	0.50	0.00
3	0.000000332	0.00003	2.862	225.	55.	10.	10.	0.50	0.00
3	0.000000332	0.00003	2.862	225.	45.	10.	10.	0.50	0.00
3	0.000000332	0.00003	2.862	225.	35.	10.	10.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	20.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	00.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	00.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	-20.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	165.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	180.	-40.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	160.	-40.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-10.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-30.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-50.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-70.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-75.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-75.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-105.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-105.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	-75.	30.	30.	0.50	0.00

3	0.000000332	0.00030	2.862	105.	-105.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	160.	-60.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-75.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-105.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	55.	-135.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	85.	-135.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	115.	-135.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	80.	-160.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	100.	-160.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	180.	-60.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	160.	-70.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	160.	-100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	140.	-130.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	120.	-160.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	95.	-185.	30.	30.	0.50	0.00
		===========							
TOTAL EMISSIONS		0.01670							

NOTE: SOME SOURCE EMISSION RATES ARE A FUNCTION OF WIND SPEED AND TOTAL IS NOT CORRECT

1

8760 HOUR AVERAGE FOR HOUR ENDING 8760
CONCENTRATIONS IN MICROGRAMS/M**3

(864., 651., 0.623) (875., 505., 0.698) (870., 351., 0.771)
(886., 222., 0.665) (

1

8760 HOUR AVERAGE FOR HOUR ENDING 8760
DEPOSITION RATE IN MICROGRAMS/M**2/SEC

(864., 651., 0.000) (875., 505., 0.000) (870., 351., 0.000)
(886., 222., 0.000) (

ATTACHMENT 5

ANNUAL PM_{10} IMPACTS IN 1990 AT FOUR RECEPTORS ALONG THE PIPELINE SEPARATING PROCTOR, WEST VIRGINIA FROM THE OHIO RIVER

1

FUGITIVE DUST MODEL (FDM)
VERSION 91070
MAR, 1991

RUN TITLE:
ponds 4 & 5 Annual Impacts at Proctor, WV

INPUT FILE NAME: proctor.dat
OUTPUT FILE NAME: 90b.out
MET DATA READ FROM FILE NAME: ormet_90.bin
PLOT OUTPUT WRITTEN TO FILE NAME: 90b.plt

CONVERGENCE OPTION 1=OFF, 2=ON	1
MET OPTION SWITCH, 1=CARDS, 2=PREPROCESSED	2
PLOT FILE OUTPUT, 1=NO, 2=YES	2
MET DATA PRINT SWITCH, 1=NO, 2=YES	1
POST-PROCESSOR OUTPUT, 1=NO, 2=YES	1
DEP. VEL./GRAV. SETL. VEL., 1=DEFAULT, 2=USER	1
PRINT 1-HOUR AVERAGE CONCEN, 1=NO, 2=YES	1
PRINT 3-HOUR AVERAGE CONCEN, 1=NO, 2=YES	1
PRINT 8-HOUR AVERAGE CONCEN, 1=NO, 2=YES	1
PRINT 24-HOUR AVERAGE CONCEN, 1=NO, 2=YES	1
PRINT LONG-TERM AVERAGE CONCEN, 1=NO, 2=YES	2
BYPASS RAMMET CALMS RECOGNITION, 1=NO, 2=YES	0
NUMBER OF SOURCES PROCESSED	80
NUMBER OF RECEPTORS PROCESSED	4
NUMBER OF PARTICLE SIZE CLASSES	0
NUMBER OF HOURS OF MET DATA PROCESSED	8760
LENGTH IN MINUTES OF 1-HOUR OF MET DATA	60.
ROUGHNESS LENGTH IN CM	100.00
SCALING FACTOR FOR SOURCE AND RECPTORS	1.0000
PARTICLE DENSITY IN G/CM**3	2.00
ANEMOMETER HEIGHT IN M	10.00

PREPROCESSED METEOROLOGICAL DATA SELECTION SWITCHES
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11111111111111111111111111111111111111111111111111111111111111111111111111111111
111111111111111111111111111111111111111111111110

1

RECEPTOR COORDINATES (X,Y,Z)

(864., 651., 00.) (875., 505., 00.) (870., 351., 00.)
(886., 222., 00.) (
1

SOURCE INFORMATION

TYPE	ENTERED EMIS. RATE (G/SEC, G/SEC/M OR G/SEC/M**2)	TOTAL EMISSION RATE (G/SEC)	WIND SPEED FAC.	X1 (M)	Y1 (M)	X2 (M)	Y2 (M)	HEIGHT (M)	WIDTH (M)
3	0.000000332	0.00030	2.862	-25.	-55.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	-55.	-55.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	-85.	-55.	30.	30.	0.50	0.00

3	0.000000332	0.00013	2.862	-115.	-70.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-90.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-110.	-50.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-70.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-70.	-100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-130.	-30.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	-105.	-25.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	-75.	-25.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	-50.	-30.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-50.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-30.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00003	2.862	65.	85.	10.	10.	0.50	0.00
3	0.000000332	0.00013	2.862	170.	70.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	145.	85.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	115.	85.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	85.	75.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	60.	70.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	100.	100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	80.	100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	60.	100.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	165.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	165.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	60.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	40.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	20.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	60.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	40.	20.	20.	0.50	0.00
3	0.000000332	0.00003	2.862	225.	55.	10.	10.	0.50	0.00
3	0.000000332	0.00003	2.862	225.	45.	10.	10.	0.50	0.00
3	0.000000332	0.00003	2.862	225.	35.	10.	10.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	20.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	00.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	00.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	-20.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	165.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	180.	-40.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	160.	-40.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-10.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-30.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-50.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-70.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-75.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-75.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-105.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-105.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	-75.	30.	30.	0.50	0.00

3	0.000000332	0.00030	2.862	105.	-105.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	160.	-60.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-75.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-105.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	55.	-135.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	85.	-135.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	115.	-135.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	80.	-160.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	100.	-160.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	180.	-60.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	160.	-70.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	160.	-100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	140.	-130.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	120.	-160.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	95.	-185.	30.	30.	0.50	0.00
		===========							

TOTAL EMISSIONS 0.01670

NOTE: SOME SOURCE EMISSION RATES ARE A FUNCTION OF WIND SPEED AND TOTAL IS NOT CORRECT

1

8760 HOUR AVERAGE FOR HOUR ENDING 8760
CONCENTRATIONS IN MICROGRAMS/M**3

(864., 651., 0.681) (875., 505., 0.776) (870., 351., 0.831)
(886., 222., 0.684) (

1

8760 HOUR AVERAGE FOR HOUR ENDING 8760
DEPOSITION RATE IN MICROGRAMS/M**2/SEC

(864., 651., 0.000) (875., 505., 0.000) (870., 351., 0.000)
(886., 222., 0.000) (

ATTACHMENT 4

E^2M FDM RESULTS AT RECEPTOR R_4

```
1
                    FUGITIVE DUST MODEL (FDM)
                    VERSION 91070
                    MAR, 1991

     RUN TITLE:
          ponds 4 & 5 Annual Impacts at Proctor, WV

          INPUT FILE NAME: 89d.dat
          OUTPUT FILE NAME: 89d.out
          MET DATA READ FROM FILE NAME: ormet_89.bin
          PLOT OUTPUT WRITTEN TO FILE NAME: 89d.plt


          CONVERGENCE OPTION 1=OFF, 2=ON                          1
          MET OPTION SWITCH, 1=CARDS, 2=PREPROCESSED              2
          PLOT FILE OUTPUT, 1=NO, 2=YES                           2
          MET DATA PRINT SWITCH, 1=NO, 2=YES                      1
          POST-PROCESSOR OUTPUT, 1=NO, 2=YES                      1
          DEP. VEL./GRAV. SETL. VEL., 1=DEFAULT, 2=USER           1
          PRINT 1-HOUR AVERAGE CONCEN, 1=NO, 2=YES                1
          PRINT 3-HOUR AVERAGE CONCEN, 1=NO, 2=YES                1
          PRINT 8-HOUR AVERAGE CONCEN, 1=NO, 2=YES                1
          PRINT 24-HOUR AVERAGE CONCEN, 1=NO, 2=YES               1
          PRINT LONG-TERM AVERAGE CONCEN, 1=NO, 2=YES             2
          BYPASS RAMMET CALMS RECOGNITION, 1=NO, 2=YES            0
          NUMBER OF SOURCES PROCESSED                            80
          NUMBER OF RECEPTORS PROCESSED                           1
          NUMBER OF PARTICLE SIZE CLASSES                         0
          NUMBER OF HOURS OF MET DATA PROCESSED                8760
          LENGTH IN MINUTES OF 1-HOUR OF MET DATA               60.
          ROUGHNESS LENGTH IN CM                             100.00
          SCALING FACTOR FOR SOURCE AND RECPTORS             1.0000
          PARTICLE DENSITY IN G/CM**3                          2.00
          ANEMOMETER HEIGHT IN M                              10.00

          PREPROCESSED METEOROLOGICAL DATA SELECTION SWITCHES
          11111111111111111111111111111111111111111111111111111111111111111111111111111111
          11111111111111111111111111111111111111111111111111111111111111111111111111111111
          11111111111111111111111111111111111111111111111111111111111111111111111111111111
          11111111111111111111111111111111111111111111111111111111111111111111111111111111
          1111111111111111111111111111111111111111111110
1

          RECEPTOR COORDINATES (X,Y,Z)

(    768.,     220.,    3.)  (
1

          SOURCE INFORMATION

                 ENTERED EMIS.     TOTAL
                  RATE (G/SEC,   EMISSION    WIND
```

TYPE	G/SEC/M OR G/SEC/M**2)	RATE (G/SEC)	SPEED FAC.	X1 (M)	Y1 (M)	X2 (M)	Y2 (M)	HEIGHT (M)	WIDTH (M)
3	0.000000332	0.00030	2.862	-25.	-55.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	-55.	-55.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	-85.	-55.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	-115.	-70.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-90.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-110.	-50.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-70.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-70.	-100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-130.	-30.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	-105.	-25.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	-75.	-25.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	-50.	-30.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-50.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	-30.	-80.	20.	20.	0.50	0.00
3	0.000000332	0.00003	2.862	65.	85.	10.	10.	0.50	0.00
3	0.000000332	0.00013	2.862	170.	70.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	145.	85.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	115.	85.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	85.	75.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	60.	70.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	100.	100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	80.	100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	60.	100.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	165.	45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	165.	15.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	60.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	40.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	20.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	60.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	40.	20.	20.	0.50	0.00
3	0.000000332	0.00003	2.862	225.	55.	10.	10.	0.50	0.00
3	0.000000332	0.00003	2.862	225.	45.	10.	10.	0.50	0.00
3	0.000000332	0.00003	2.862	225.	35.	10.	10.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	20.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	00.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	210.	00.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	190.	-20.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	165.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	180.	-40.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	160.	-40.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-15.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-15.	30.	30.	0.50	0.00

3	0.000000332	0.00013	2.862	20.	-10.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-30.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-50.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-45.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	20.	-70.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-75.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-75.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	45.	-105.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	75.	-105.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	-75.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	105.	-105.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	160.	-60.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-75.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	135.	-105.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	55.	-135.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	85.	-135.	30.	30.	0.50	0.00
3	0.000000332	0.00030	2.862	115.	-135.	30.	30.	0.50	0.00
3	0.000000332	0.00013	2.862	80.	-160.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	100.	-160.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	180.	-60.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	160.	-70.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	160.	-100.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	140.	-130.	20.	20.	0.50	0.00
3	0.000000332	0.00013	2.862	120.	-160.	20.	20.	0.50	0.00
3	0.000000332	0.00030	2.862	95.	-185.	30.	30.	0.50	0.00

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TOTAL EMISSIONS 0.01670

NOTE: SOME SOURCE EMISSION RATES ARE A FUNCTION OF WIND SPEED AND TOTAL IS NOT CORRECT

1

8760 HOUR AVERAGE FOR HOUR ENDING 8760

CONCENTRATIONS IN MICROGRAMS/M**3

(768., 220., 0.923) (

1

8760 HOUR AVERAGE FOR HOUR ENDING 8760

DEPOSITION RATE IN MICROGRAMS/M**2/SEC

(768., 220.,**********) (

****** NOTE: FOR RECEPTORS WITH Z UNEQUAL 0, DEPOSITION IS SET TO 999999.999

ATTACHMENT "C"

Ohio Department Of Development Census Data
(Provided By Gil Rojas, Ohio Department Of Development)

OHIO - POPULATION BY COUNTY AND HOUSING UNITS ALPHABETICALLY: 1990

TABLE 2

Name	Total	White	Black	American Indian, Eskimo or Aleut	Asian or Pacific Islander	Other Race	Hispanic Origin*	Housing Units
OHIO	10,847,115	9,521,756	1,154,826	20,358	91,179	58,996	139,696	4,371,94[illegible]
Marion County	64,274	60,948	2,707	148	285	186	465	25,14[illegible]
Medina County	122,354	120,504	850	172	684	144	711	43,33[illegible]
Meigs County	22,987	22,734	177	44	20	12	59	9,79[illegible]
Mercer County	39,443	39,131	14	85	100	113	280	14,98[illegible]
Miami County	93,182	90,519	1,779	158	606	120	366	35,98[illegible]
Monroe County	15,497	15,437	19	26	12	3	24	6,56[illegible]
Montgomary County	573,809	463,551	101,817	1,065	5,886	1,490	4,539	240,82[illegible]
Morgan County	14,194	13,524	570	64	12	24	36	6,581
Morrow County	27,749	27,579	64	49	38	19	92	10,312
Muskingum County	82,068	78,125	3,488	214	152	109	247	33,029
Noble County	11,336	11,301	7	15	9	4	23	4,998
Ottawa County	40,029	39,029	265	51	94	590	1,491	23,340
Paulding County	20,488	19,920	236	54	20	258	628	7,951
Perry County	31,557	31,408	57	46	21	25	81	[illegible]260
Pickaway County	48,255	44,867	3,036	127	95	130	323	[illegible].385
Pike County	24,249	23,807	327	72	41	2	74	9,722
Portage County	142,585	136,998	3,906	292	1,191	198	798	52,299
Preble County	40,113	39,819	147	53	65	29	105	15,174
Putnam County	33,819	33,197	26	44	25	527	1,418	11,600
Richland County	126,137	115,078	9,981	223	578	277	903	50,350
Ross County	69,330	64,362	4,467	155	266	80	346	26,173
Sandusky County	61,963	58,282	1,553	94	142	1,892	3,544	23,753
Scioto County	80,327	77,253	2,458	409	128	81	281	32,408
Seneca County	59,733	57,474	1,172	90	234	763	1,676	22,473
Shelby County	44,915	43,789	615	49	393	69	185	16,509
Stark County	367,585	339,421	25,052	950	1,529	633	2,755	146,910
Summit County	514,990	446,902	61,185	1,065	4,989	849	3,017	211,477
Trumbull County	227,813	210,915	15,221	341	973	363	1,454	90,533
Tuscarawas County	84,090	83,107	623	138	187	35	228	33,982
Union County	31,969	30,563	1,168	57	132	49	159	11,599
Van Wert County	30,464	29,900	193	31	78	262	482	1[illegible],998
Vinton County	11,098	11,071	4	16	3	4	33	[illegible]156
Warren County	113,909	110,526	2,415	231	627	110	524	[illegible],638
Washington County	62,254	61,129	774	111	185	55	225	25,752
Wayne County	101,461	99,131	1,557	130	535	108	429	37,036
Williams County	36,956	36,366	23	48	127	394	826	14,745
Wood County	113,269	109,303	1,168	197	1,028	1,573	2,882	41,760
Wyandot County	22,254	22,087	20	20	65	62	162	8,596

* Persons of Hispanic origin can be of any race.

THE POPULATION COUNTS SET FORTH HEREIN ARE SUBJECT TO POSSIBLE CORRECTION FOR UNDERCOUNT OR OVERCOUNT.

THE UNITED STATES DEPARTMENT OF COMMERCE IS CONSIDERING WHETHER TO CORRECT THESE COUNTS AND WILL PUBLISH CORRECTED COUNTS, IF ANY, NOT LATER THAN JULY 15, 1991.

STF3 TARGET REPORT 10: RACE AND HOUSING UNIT DATA

FROM U.S. BUREAU OF THE CENSUS SUMMARY TAPE FILE 3: TABLES 1, 10, 12, 14, & 97
PREPARED BY THE OHIO DATA USERS CENTER, DECEMBER 1982

GEOGRAPHIC AREA					POPULATION INFORMATION							HOUSING UNIT DATA		
CO	MCD	AREANAME	TRACT	BG/ED	TOTAL POP	WHITE	BLACK	AM. INDIAN ESKIMO ALEUT	ASIAN P.I.	OTHER	SPANISH ORIGIN (ALL RACES)	OCCUPIED UNITS	OWNER OCC	RENT 0
095		LUCAS			471741	397377	64140	1150	2882	6192	12754	172239	119770	57
097		MADISON			33004	31292	1508	60	87	57	129	10661	7322	3
099		MAHONING			289487	245290	41067	357	758	2015	5363	102560	74692	27
101		MARION			67974	65430	2216	95	148	85	461	23798	17465	6
103		MEDINA			113150	111708	856	146	322	118	681	35979	28760	7
105		MEIGS			23641	23355	225	41	12	8	139	8412	6653	1
107		MERCER			38334	38083	14	82	50	105	342	12166	9844	2
109		MIAMI			90381	88196	1793	111	235	46	393	31968	23930	8
111		MONROE			17382	17366	5	5	6	0	24	5964	4845	1
113		MONTGOMERY			571697	471778	94702	764	3165	1288	3913	211857	136746	75
115		MORGAN			14241	13631	514	53	22	21	59	4912	3864	1
117		MORROW			26480	26322	33	26	69	30	111	8773	7310	1
119		MUSKINGUM			83340	79390	3642	123	133	52	190	29442	21877	7
121		NOBLE			11310	11275	0	29	6	0	24	3948	3094	
123		OTTAWA			40076	39379	216	40	33	408	1207	14202	11291	2
125		PAULDING			21302	20803	217	16	12	254	488	7007	5876	1
127		PERRY .			31032	30927	60	10	20	15	160	10525	8406	2
129		PICKAWAY			43662	42924	575	61	66	36	231	14156	10036	4
131		PIKE			22802	22380	240	104	65	13	140	7701	5541	2
133		PORTAGE			135856	131183	3464	165	894	150	610	44214	31388	12
135		PREBLE			38223	37926	223	37	21	16	68	13122	10086	3
137		PUTNAM			32991	32292	17	10	12	660	1141	10110	8567	1
139		RICHLAND			131205	121042	9313	196	379	275	1046	46408	33608	12
141		ROSS			65004	61280	3327	102	214	81	351	22042	15508	6
143		SANDUSKY			63267	60555	1348	104	104	1156	3132	21553	16373	5
145		SCIOTO			84545	81684	2447	190	177	47	386	29534	21292	8
147		SENECA			61901	59885	1153	48	104	711	1334	20818	15510	5
149		SHELBY			43089	42439	493	4	139	14	98	14184	10729	3
151		STARK			378823	352305	24308	619	1176	415	3414	134094	96729	37
153		SUMMIT			524472	463372	56880	623	2853	744	2390	189850	132734	57
155		TRUMBULL			241863	225816	14679	229	860	279	1216	84151	62763	21
157		TUSCARAWAS			84614	83539	750	144	163	18	352	30485	23363	7
159		UNION			29536	28816	548	76	90	6	99	10015	7566	2
161		VAN WERT			30458	30072	97	14	88	187	283	10939	8787	2
163		VINTON			11584	11552	8	11	11	2	22	3924	3083	
165		WARREN			99276	97150	1574	182	302	68	359	31625	23849	7
167		WASHINGTON			64266	63086	892	87	172	29	199	22358	16821	5
169		WAYNE			97408	95694	1226	37	382	69	497	32233	23606	8
171		WILLIAMS			36369	35906	6	47	110	300	793	12896	10096	2
173		WOOD			107372	104038	1336	199	566	1233	2355	35477	25091	10
175		WYANDOT			22651	22501	18	26	45	61	149	7838	5979	1

ATTACHMENT "D"

Report Of Geraghty & Miller
Risk Evaluation Group, Dated November 6, 1991

November 6, 1991

Mr. John D. Reggi
Ormet Corporation
Route 7
Hannibal, OH 43931

Dear Mr. Reggi:

The Geraghty & Miller Risk Evaluation Group has reviewed the final baseline risk assessment/human health evaluation by Life Systems, Inc. (LSI), dated August 8, 1991, for the Ormet site in Hannibal, Ohio. Major deficiencies of the report are outlined in the attached document. As a result of these deficiencies, the conclusions of LSI's baseline risk assessment are invalid.

Larry Simmons from Energy and Environmental Management, Inc., has provided us with the modeled impact of fugitive emissions on Proctor, West Virginia. Based on Energy and Environmental Management, Inc.'s modeled impact of 0.92 $\mu g/m^3$, the potential excess lifetime cancer risks associated with fugitive emissions in Proctor were calculated to be 2E-08 and the hazard index was calculated to be 7E-04.

We would welcome the opportunity to discuss our findings further. Please feel free to contact me at (919) 571-1662.

Sincerely,

GERAGHTY & MILLER, INC.

Carl ô [illegible] for

Frank A. Jones, ~~Ph.D.~~
Principal Toxicologist/Associate

FAJ/lmc
Attachment
PA00708

DEFICIENCIES IN THE BASELINE RISK ASSESSMENT (BRA)

1. Page 3-21, Paragraph 2, And Page 3-23, Table 3-6. The future on-site residential exposure scenario is extremely unlikely and should not be considered in the BRA. Aside from the improper consideration of this scenario, the time-weighted average breathing rates for a child are incorrect. Based upon the guidance contained in EPA's Exposure Factors Handbook (1989), the time-weighted breathing rate for a child should be 0.73 m^3/hr. for 20 hours of indoor exposure and 1.5 m^3/hr. for 4 hours of outdoor exposure.

   According to EPA's Exposure Factors Handbook, sleeping, watching television, reading and other passive leisure activities comprise the majority of the typical child's day (USEPA, Exposure Factors Handbook, 1989). Outdoor activities account for less than 5 percent of a child's typical daily activities (USEPA, Exposure Factors Handbook, 1989). The time-weighted average contained in the BRA is based upon an unjustifiably high number of active hours and too few passive hours for the typical child. This exposure assumption also fails to take into account the fact that children do not remain in the same location all day every day.

2. Page 3-22, Table 3-5. EPA's Risk Analysis of TCDD Contaminated Soil (1984) indicates that only 12.5 percent of the dust inhaled is absorbed through the lungs, the remaining 87.5 percent is trapped in the mucous of the lungs and is transported back out of the lungs and expectorated or swallowed. The BRA incorrectly assumes that the average person will absorb 100 percent of the respirable material inhaled in his or her lungs. The estimate of inhalation exposure is overestimated by a factor of eight.

   Not only is this 100 percent inhalation and absorption factor wrong, it leads to a double-counting problem because the fraction of inhaled dust that is swallowed is factored into the daily estimate of soil ingestion.

3. Page 3-24, Paragraph 2. Current EPA guidance recommends a water ingestion rate for workers of 1 liter per day (USEPA Interim Final Supplemental Guidance for Risk Assessment, 1991). Ignoring the EPA recommended water ingestion rate has resulted in an overestimation of the risks posed to the future hypothetical worker from drinking untreated water derived from the plume beneath the site by a factor of two.

4. Page 3-31, Paragraph 5. In the absence of site-specific data, current EPA guidance recommends a soil adherence factor of 1 mg/cm^2 (USEPA Interim Final Supplemental Guidance for Risk Assessment, 1991). The soil adherence

factor of 2 mg/cm^2 contained in the BRA is not based on site-specific data. Thus, the BRA overestimates the exposure scenario for dermal contact by a trespasser by a factor of two.

5. Page A3-66. The 95 percent UCL for Aroclor 1242 exceeds the maximum detected concentration. EPA guidance states that when the 95 percent UCL exceeds the maximum concentration detected, the maximum concentration should be substituted for the UCL (USEPA Risk Assessment Guidance for Superfund, Volume 1, 1989). In this case, even the use of the maximum detected value to estimate exposure concentrations could be regarded as an overly conservative estimate (USEPA Risk Assessment Guidance for Superfund, Volume 1, 1989).

6. Page ES-9, Paragraph 2, And Page 5-5, Paragraph 1. Because arsenic was not detected in two of the three samples analyzed (detection limit 0.004 mg/l) and only detected in the third sample at a concentration slightly in excess of the detection limit (0.005 mg/l), no bioaccumulation scenario for arsenic should have been evaluated. Based on the analytical data available, it is unlikely that dissolved arsenic is even present in the surface water at detectable concentrations.

7. <u>Page ES-19, Paragraph 2, And Page 3-18, Paragraph 4</u>. The assumptions regarding future hypothetical concentrations of site-related constituents which might migrate to the CAC Ranney well are not based on any modeling or realistic projections. Indeed, there is substantial uncertainty over whether site-related constituents would reach the CAC Ranney well and if so, at what concentrations, if the hydraulic divide between the site and CAC was not maintained. The BRA uses data collected from the monitoring-well system without accounting for attenuation and dilution or the fact that most of the constituents of concern are relatively immobile in ground water. Accordingly, the constituent concentrations used in the BRA in conjunction with the hypothetical future impacts at the CAC Ranney well are grossly overestimated and must be revised.

8. <u>Page ES-19, Paragraph 2, Bullet 4, And Page 3-30, Table 3-10</u>. Unrealistic assumptions are used throughout the BRA to calculate potential exposure scenarios. Two of the most absurd assumptions are inhalation assumptions and fish ingestion assumptions for children. The assumption that a child aged 1 to 6 will eat as much fish as an adult is patently absurd. Similarly, assuming a resident of Proctor, West Virginia will inhale fugitive particulate matter from the site 24 hours per day for 70 years has recently been recognized by EPA as improper. USEPA Interim Final Supplemental Guidance for Risk Assessment (1991) notes the

equation to calculate residential exposure to soil/dust includes an exposure duration of 30 years, not 70 years; and an exposure frequency of 350 days/year, not 365 days/year as used in the BRA.

9. Page 3-22, Table 3-5. The assumptions employed in the BRA for this scenario are incorrect. Adult and child residents are assumed to ingest soil 365 days per year. This does not account for winter when the ground is covered with snow or days when it is raining. Additionally, the amount of dust hypothetical adult and child residents would ingest indoors would be significantly lower than the 100 to 200 mg/day estimated for ingestion while outside.

10. Page 3-27, Paragraph 4. Once a week exposure for the future trespassing may also be unjustifiably high given the fact that the site is periodically patrolled by security. The assumption that a child will trespass every non-winter week for 10 years goes beyond reasonable. Assuming a child will trespass once each non-winter month for 10 years at a site periodically patrolled by security is a more accurate representation of reasonable maximum exposure.

11. Pages A3-60 And A3-66. The subsistence fish ingestion scenario is extremely unrealistic for this site; therefore, this scenario should not be included in the BRA. Regardless of the propriety of evaluating this scenario, the

bioaccumulation factors used are invalid. The fish bioconcentration factors used to calculate human health exposure are not consistent with the values that are reported in the environmental assessment prepared for the Ormet site. The bioconcentration factors from the environmental assessment should be consistent with the ecological study performed of the site.

ORMET CORPORATION
P.O. BOX 176
HANNIBAL, OHIO 43931
(614) 483-1381 Fax: (614) 483-2622

April 14, 1992

Hazardous Waste Enforcement Branch (5HS-11)
Attn: Rhonda E. McBride
Ormet Corporation RPM
Waste Management Division
U. S. Environmental Protection Agency
Region V
230 S. Dearborn Street
Chicago, IL 60604

Ohio Environmental Protection Agency, SEDO
Attn: Richard Stewart
Ormet Site Coordinator
2195 Front Street
Logan, OH 43138

RE: Baseline Risk Assessment Dispute Resolution

Dear Ms. McBride and Mr. Stewart:

Ormet Corporation has reviewed the "Baseline Risk Assessment - Human Health Evaluation" (the "BRA") prepared by Life Systems, Inc. for the United States Environmental Protection Agency ("U.S. EPA"). Although Ormet does not agree with the Agencies' position on each of the issues raised in the Notice of Dispute and the Agencies' revisions to the BRA, Ormet is willing to accept the revised BRA for purposes of resolving the pending dispute and continuing to move forward in the remedial investigation/feasibility study ("RI/FS") process, with the exception noted immediately below.

A calculation error appears to have been made with regard to the current resident non-carcinogenic particulate inhalation hazard index value. The summation of values on pages A5-16 and A5-17 for the chronic hazard index is 2E-02, while the value listed in Tables ES-7 (page ES-14) and 5-4 (page 5-7) is 1E-01. Both values are below one and support the conclusion that non-carcinogenic risks associated with fugitive dust emissions from the Ormet Corporation Site are of no practical significance. Nonetheless, the erroneous value reported in the BRA over-estimates the actual risk by a significant factor. Indeed, the 1E-01 value is ten times lower than the acceptable level of 1, while the correct 2E-02 shows that any non-carcinogenic risks associated with fugitive dust emissions are fifty times lower than acceptable concentrations. The BRA must be revised to correct this error.

Ms. Rhonda E. McBride
Mr. Richard Stewart
April 14, 1992
Page 2

In addition, an item that was not appropriately clarified in the BRA is the bio-concentration factor ("BCF") for polychlorinated biphenyls ("PCBs"). Although the values used in the human health assessment are inconsistent with the values used in the environmental assessment, the U.S. EPA ambient water quality criteria ("AWCA") for PCBs is given as a citation in Table 3-5 (page 3-22) for the BCF of 114,400 L/Kg used in the fish ingestion scenario. In using this AWQC citation, Life Systems failed to note that the procedure used in calculating the concentration in fish tissue is used in the AWQC for calculation of "marketability for human consumption," (i.e., commercial fishing). The AWQC also includes a calculation in which the fish tissue concentration is based on the "highest BCF for edible portion of consumed species" (fresh water). The BCF used in this calculation was 9,550 L/Kg. Thus, in the AWQC it is recognized that the high theoretical BCF value is not consistent with the actual BCF values. The theoretical BCF used in the calculation of fish ingestion exposures was more than an order of magnitude higher than the highest BCF for edible portions of fish. The exposure scenario identified in the BRA was for recreational fishing, as opposed to commercial fishing.

Ormet Corporation requests that U.S. EPA reconsider the position expressed by Rhonda McBride in our April 7, 1992, telephone conversation, wherein it was stated that U.S. EPA would not be willing to further revise the BRA to note that the BCF employed will likely result in additional overestimation in potential fish ingestion risks by at least an order of magnitude. In the spirit of cooperation, however, we are willing to utilize the revised BRA, providing the current resident non-carcinogenic particulate inhalation hazard index is corrected, and to proceed to work toward a resolution of the RI/FS process. In so doing, we, of course, reserve our right to take exception and comment upon the BRA at the appropriate time.

Very truly yours,

John D. Reggi /SFF
John D. Reggi

cc: Mary Butler, Esquire
Cynthia A. Hafner, Esquire
Eugene R. Bolo, P.E.
Frank A. Jones, Ph.D.
Richard S. Wiedman, Esquire

ORM CORPORATION
P.O. BOX 176
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(614) 483-1381 Fax: (614) 483-2622

June 9, 1993

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Ms. Rhonda E. McBride
Ormet Corporation RPM
Hazardous Waste Enforcement Branch (5HS-11)
Waste Management Division
U. S. Environmental Protection Agency
Region V
230 South Dearborn Street
Chicago, IL 60604

RE: **Dispute Resolution Under the Ormet Corporation Administrative Order By Consent Re: Remedial Investigation and Feasibility Study; U.S. EPA Docket No. V-W-87-013**

Dear Ms. McBride:

Pursuant to Section XX of the above-referenced Administrative Order By Consent (the "CO"), Ormet Corporation ("Ormet") is hereby invoking the dispute resolution procedures provided therein. As required by Section XX of the CO, this letter identifies the specific points of the dispute, Ormet's position regarding these points, the bases for Ormet's position and the actions Ormet considers to be necessary.

A. Specific Points Of Dispute

This Notice of Dispute concerns the assessment of stipulated penalties under Section XIX of the CO for Ormet Corporation's ("Ormet's") alleged failure to submit the revised Feasibility Study (the "FS") Report within the time period required by the CO. The March 24, 1993, deadline selected by the United States Environmental Protection Agency ("EPA") for the submission of the revised FS Report is not correct and is not supported by the CO. Moreover, even if it is assumed that the deadline was March 24 (and it was not), the assessment of stipulated penalties is entirely inappropriate in light of the circumstances surrounding the revisions requested by EPA and the Ohio Environmental Protection Agency ("Ohio EPA").

In January, 1993, EPA and Ohio EPA (referred to collectively as the "Agencies"), after a review period of over a year, provided Ormet with 27 pages of comments on the Draft FS Report. Ormet analyzed the Agencies' comments and notified the Agencies within the time frame specified by the CO that a meeting would be necessary to discuss certain comments. At the project review meeting, many of Ormet's questions on the Agencies' comments were resolved. The Agencies were, however, unable to clarify or explain certain of their comments and the Agencies agreed to provide Ormet with explanations and/or clarifications after the meeting. Ormet's requests for clarifications and explanations were not resolved until April 14, 1993 and under Section X of the CO, Ormet was not required to submit the revised FS Report to the Agencies until 20 business days from the date Ormet's requests for explanations and clarifications were resolved.

The March 24 deadline selected by EPA as the deadline for the submission of the revised FS Report ignores the effort expended by Ormet to address extremely voluminous comments which were, in many instances, inconsistent and disjointed and completely disregarded the Agencies' prior commitment to avoid propounding generic comments with directives to "change throughout the document" without providing specific references to the sections to be revised. Moreover, the March 24 deadline selected by EPA ignores the fact that it took the Agencies over a year to prepare the comments and does not account for the effort expended by Ormet to provide the Agencies with "redlined" copies of the document and annotations explaining the revisions made to the document, measures which go well beyond the requirements of the CO.[1]

Under the terms of the CO, Ormet was not required to submit the revised FS Report to the Agencies until May 12, 1993, i.e., twenty business days from April 14. Ormet submitted the revised FS Report to the Agencies on April 26, 1993, well before the deadline imposed under the terms of the CO and, thus, Ormet has fully complied with the letter and spirit of the CO and EPA is not entitled to stipulated penalties. Moreover, under the circumstances, even if the revisions to the FS Report were not submitted to the Agencies in a timely manner, which is not the case, the assessment of stipulated penalties is not appropriate. Accordingly, Ormet is invoking the Dispute Resolution procedures seeking EPA's withdrawal of its demand for stipulated penalties.

B. **The Bases For Ormet's Position**

Ormet has cooperated fully with EPA in the preparation of the FS Report, often performing tasks beyond those required by the CO to help facilitate the Agencies' review and the completion of the FS Report as quickly as possible. Ormet was obviously disappointed

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[1] Contrary to the statements contained in Ms. Traub's letter of May 17, 1993, the Agencies specifically requested Ormet to provide redlined copies of the revised document and annotations explaining the revisions. See correspondence from Rhonda McBride and Richard Stewart to John Reggi dated October 3, 1991 and January 7, 1993.

by EPA's demand for stipulated penalties given Ormet's extraordinary efforts and history of timely compliance, and the absence of any delay in this instance. EPA's demand for stipulated penalties is particularly disturbing in light of the Agencies' historical failures with respect to their deadlines under the terms of the CO, the most recent of which is documented in your letter of June 2, 1993.

Historical Context

In January, 1991 EPA sought to amend the CO to provide for the accelerated preparation of the FS Report. Although the Remedial Investigation ("RI") Report was not completed at this time and the amended schedule proposed by EPA required that the FS Report be prepared prior to completion of the RI Report, Ormet agreed to the amended schedule in order to facilitate the expeditious resolution of the RI/FS process. The Agencies, in turn, agreed not to proceed on a "piecemeal" basis and to provide Ormet with their comments and direction in an organized and orderly fashion.

Pursuant to the amended CO Ormet prepared and submitted to EPA the first three sections of the FS Report by the February 19, 1991 deadline. Ormet incurred substantial costs under this accelerated schedule, but Ormet met the deadline for the first submittal. Within 20 business days of the Agencies' receipt of the first submittal, the Agencies were required to, among other things, provide Ormet with the final Baseline Risk Assessment prepared by EPA, and a project review meeting was to be held to discuss the Agencies' comments on Ormet's first submittal. Although the Baseline Risk Assessment received from the Agencies in March 1991 was supposed to be the final Baseline Risk Assessment for the Ormet Site, the document was deficient and had to be substantially revised twice and was not finalized by EPA until March, 1992.[2]

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[2] One of the most serious flaws in the Baseline Risk Assessment involved EPA's failure to properly perform the air modeling study as agreed between Ormet and the Agencies to model air transport of fugitive particulate matter from potential source areas at the Ormet Site. (For a description of the deficiencies in the Baseline Risk Assessment, See Ormet's Notice of Dispute dated November 7, 1991).

One of the more glaring examples of the inadequacy of the air modeling study was the failure to model potential impacts at the selected receptor located across the Ohio River from the Ormet Site. Because EPA's contractor, Life Systems, Inc., inverted the coordinate system used in the air modeling study, the study was initially performed on a receptor point located in an unpopulated area on the wrong side of the Ohio River. EPA and a second EPA contractor, Metcalf and Eddy, Inc., failed to correct this fatal flaw when the modeling study was reviewed prior to being published in "final form."

(continued...)

As required by the amended CO a project review meeting was scheduled for March 19 and 20, 1991, at which the Agencies were required to present their comments on the first FS submittal for discussion with Ormet. Ormet confirmed these meeting dates the week prior to the meeting as well as the day before the scheduled meeting date when Ormet and its representatives were present in Columbus preparing to meet with the Agencies and the Agencies confirmed that they were prepared to meet with Ormet. Representatives of Ormet, including a representative from Ormet's environmental management staff and a representative of ORALCO Management Services, Inc., two attorneys from the law firm of Eckert Seamans Cherin & Mellott, and five consultants from the consulting firm of Geraghty & Miller, Inc., each person having traveled significant distances to meet with the Agencies, were kept waiting in Columbus, Ohio for a day and a half until the Agencies cancelled the meeting after the originally scheduled meeting time on March 19. The reason given to Ormet by the Agencies for cancelling the meeting was that the Agencies had not completed their internal discussions and were not prepared to meet with Ormet. The Agencies directed that the meeting be rescheduled and the parties agreed to a meeting date of April 10 and 11, 1991. Final comments on the first FS submittal were not received from the Agencies until March 29. In addition, although it was agreed that the Agencies would provide Ormet with comments on the RI Report under Agency review for discussion at the April 10 and 11 meetings, the Agencies failed to provide Ormet with these comments because EPA was unable to finalize them in time for the April meeting.

The Agencies' piecemeal approach to the preparation of the FS Report and the completion of the RI Report and the cancellation of the March, 1991 project review meeting after the scheduled starting time wasted a great deal of Ormet's time, money and resources. In particular, the expenses associated with having the necessary array of consultants present in Columbus to address the issues to be discussed at the cancelled meeting exceeded $20,000.

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[2](...continued)
Upon reviewing the Baseline Risk Assessment and the air modeling study, Ormet and its consultant, Energy and Environmental Management, Inc., immediately realized that the modeling study was flawed. Therefore, Ormet conducted its own modeling study, found the flaws in EPA's study and provided EPA's contractor with a data file which enabled EPA's contractor to correct some of the more serious flaws.

Ormet incurred substantial costs in terms of time, money and resources in correcting EPA's deficient work. EPA and its contractors refused to correct all of the deficiencies in their modeling study, but in an effort to move forward toward the resolution of the RI/FS process, Ormet agreed to accept EPA's deficient air modeling study in the Baseline Risk Assessment.

The Agencies' 1993 Comments

At the February, 1993 project review meeting held in Columbus, Ohio to discuss the Agencies' latest round of comments, Ormet asked the Agencies to clarify what they meant when they directed Ormet to develop a "flood dike" in conjunction with capping the Construction Materials Scrap Dump ("CMSD"). The Agencies tabled this issue so that it could be discussed internally. After the second day of the project review meeting the Agencies told Ormet that they would need to consult with their respective program personnel and that the Agencies would get back to Ormet during the week of February 22. After the project review meeting, the Agencies contacted Ormet and the parties agreed to discuss the Agencies' "flood dike" comment via a conference call on February 23. During the conference call on February 23, the Agencies directed Ormet to develop a "floodwall" consisting of an impermeable barrier or wall around the CMSD. Over the next several weeks Ormet had its engineering consultant evaluate the feasibility of a "floodwall" around the CMSD.

On March 22 another conference call was convened to discuss the floodwall issue and at Ormet's request Ohio EPA agreed to provide an example of a "floodwall." The example of the "floodwall" provided by Ohio EPA was a wall approximately 8 feet tall and approximately 25 feet wide at the bottom and approximately 7 feet wide at the top. Although Ormet questioned the basis for this Agency directive, Ormet immediately requested its engineering consultant to review the example provided by Ohio EPA and to evaluate the feasibility of implementing such a design at the Ormet Site. During a conference call with the Agencies on March 25, Ormet indicated that the dimensions of the "floodwall" would present significant problems for the Ormet Site because the CMSD is located immediately adjacent to the Ohio River and construction of a stable floodwall would require a structure extending approximately 30 feet into the Ohio River. Moreover, construction of a "floodwall" would require the construction of a temporary coffer dam approximately 50 to 60 feet into the Ohio River. Nonetheless, Ormet indicated that it would continue to evaluate the feasibility of the project.

During a conference call on April 12, 1993, Ormet reiterated its questions regarding the relevance of and basis for the directive to Ormet to incorporate a "floodwall" as a component of a cap for the CMSD. The Agencies indicated that they "would not answer questions," but directed Ormet to develop a remedial measure which would "prevent washout and inundation." On April 14, Ormet again contacted the Agencies in order to finally resolve the "floodwall" issue. During this conference call, Ormet indicated that it believed that the "floodwall" contemplated by the Agencies was not necessary to prevent inundation and washout. After some discussion the Agencies responded that Ormet could include in the FS Report whatever Ormet believed would prevent washout and the Agencies rescinded their prior directive regarding the development of a "floodwall." Thus, Ormet's questions on the Agencies' comments were not finally resolved until April 14, 1993.

Tasks Beyond The Scope Of The CO

At the request of the Agencies, Ormet has provided "redlined" copies of revisions to the FS Report and annotations to the revisions to help the Agencies in their review process. The redlining and preparation of annotations is a time-consuming, burdensome and costly endeavor which constitute tasks beyond those required of Ormet by the CO. Nonetheless, Ormet agreed to accommodate the Agencies to facilitate an expeditious review by the Agencies. Even if the March 24 deadline selected by EPA for completion of the revisions to the FS Report was accurate (and it is not), because these measures constitute tasks outside of the scope of work incorporated by reference into the CO and because of the sheer dimensions of the tasks resulting from the comments could not reasonably be addressed in the time period in question, Ormet was entitled to additional time for preparation of these items and the assessment of stipulated penalties under the circumstances is unreasonable. Indeed, the Agencies' most recent failure to meet their deadline of 20 business days to review the revisions which were "redlined" and included annotations to assist in the review is testimony to the difficulty of the tasks performed by Ormet.

E. **Action Requested**

Ormet has expended a great deal of time and money to assist EPA and its contractors with the expeditious review of the FS Report. Moreover, Ormet has patiently worked with the Agencies to ascertain and respond to the precise nature of the Agencies' comments and directives. The Agencies' assessment of stipulated penalties is not justified under either the letter or spirit of the amended CO. Accordingly, Ormet is requesting that EPA withdraw its demand for stipulated penalties.

Very truly yours,

J D Reggi

J. D. Reggi, Manager
Corporate Environmental Services

cc: Jo Lynn Traub
Tinka Hyde
Elizabeth Murphy, Esq.
Richard Stewart
E. R. Bolo, P.E.
R. S. Wiedman, Esq.

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RICHARD S. WIEDMAN
(412) 566-5967

February 28, 1991

VIA FEDERAL EXPRESS

Jane M. Lupton, Esq.
United States Environmental
Protection Agency - Region V
230 South Dearborn Street
Chicago, IL 60604

Attention: 5CS-16

RE: Ormet Corporation

Dear Jane:

This will confirm our conversation of February 27, 1991 in which you confirmed that our letter of January 7, 1991 (attached) accurately reflects the agreements which resulted from our discussions in December. As I pointed out when we spoke, Ormet's willingness to proceed on an accelerated basis consistent with the draft amendment to the Administrative Order by Consent which is going through its final revisions, is based in part upon Ormet's understanding and reliance upon the fact that the Agencies and Ormet are in accord with respect to the matters outlined in the January 7, 1991 letter.

Sincerely,

Richard S. Wiedman

RSW:jlv
cc: C. A. Hafner, Esq.
E. R. Bolo
J. D. Reggi
S. F. Faeth, Esq.

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TELEX-866172

RICHARD S. WIEDMAN
(412) 566-5967

January 7, 1991

Larry Johnson, Esquire
United States Environmental
Protection Agency - Region V
230 South Dearborn Street
Chicago, IL 60604

Attention: 5CS-16

Cynthia A. Hafner, Esquire
Ohio Environmental Protection
1800 WaterMark Drive
Columbus, OH 43266-0149

Re: Ormet Corporation - Administrative Order by Consent and RI/FS; U.S. EPA Docket No. V-W-87-C-013

Dear Mr. Johnson and Ms. Hafner:

This letter will confirm the agreement reached among Ormet Corporation ("Ormet"), the United States Environmental Protection Agency ("U.S. EPA") and the Ohio Environmental Protection Agency ("Ohio EPA"), regarding the schedule for the Feasibility Study and certain other matters discussed during the conference call among the parties on Wednesday, December 26, 1990. As agreed, we are enclosing a draft Amendment to Administrative Consent Order which sets forth the terms of our agreement to the extent that they impact the Consent Order. (The enclosed draft Amendment has been "red-lined" for your convenience.)

A copy of the Schedule attached to Region V's letter dated January 2, 1991, is attached hereto as Attachment A. This Schedule, to which all parties expressed their agreement on December 26, 1990, has been incorporated into Section IX, paragraphs F, G and H, of the Consent Order. Corresponding modifications to the review and approval procedures are incorporated into Section X, paragraphs 1, 2 and 3, of the Consent Order. Finally, stipulated penalties set forth in Section XIX of the Consent Order have been modified to reflect the agreed reduction of stipulated penalties to $100 per day with the initial assessment correspondingly reduced to $250.

As agreed, this will also confirm that all parties have expressly recognized that the modifications referenced herein and to be incorporated in the Consent Order in no way impinge upon Ormet's rights under the Consent Order to a day-for-day extension of Ormet's time commitments for each day of delay caused by U.S. EPA or Ohio EPA.

This will also confirm that the Agencies have relinquished any alleged claim for stipulated penalties in connection with Ormet's submittal of the FS Workplan, or any other matter which was the subject of Region V's letter to Mr. J. D. Reggi dated October 25, 1990.

This will also confirm that the draft FS Report chapters submitted to the Agencies on December 24, 1990, under the schedule set forth in the approved FS Workplan will not be reviewed and will either be returned or destroyed.

Because of the time delays associated with actually amending the Consent Order, Ormet is proceeding as if the modified schedule presently were in effect. We understand that U.S. EPA and Ohio EPA desire to complete this project on an accelerated basis. Ormet has made these commitments in an effort to accommodate the Agencies. As we discussed, in order to do so, it will not be possible to proceed on a piecemeal basis and it is imperative that the Agencies fulfill their obligations and provide input on a timely basis. This will also confirm our understanding that U.S. EPA and Ohio EPA are committed to proceeding in this fashion.

We have provided an original of this letter to each of you for countersignature. If you will return signed copies of this letter to me, we will ensure that all parties receive a complete set of countersigned documents for their respective files. Countersignatures from U.S. EPA and Ohio EPA will ensure that there is no confusion regarding the bases for the contemplated amendments and will document the resolution of those issues which do not require an amendment to the Consent Order.

Very truly yours,

Richard S. Wiedman

Acknowledged and Agreed:

U.S. EPA

Ohio EPA

Attachment A

Ormet Corporation Site Feasibility Study Schedule

Schedule	Description	Approximate Date
12/27/90	Ormet Receives Federal & State Chemical/Location Specific ARARs	Not Applicable
2/19/91 - 35 Business Days from 12/27/90	Ormet Submits FS Chapters through Development & Screening of Alternatives	Not Applicable
20 Business Days from Agencies' receipt of First FS Deliverable	Project Review Meeting & Ormet Receives Final EA and Federal & State Action Specific ARARs	3/19/91
50 Business Days from 2/19/91 or 30 Business Days from Ormet's receipt of Final EA and ARARs, whichever is later	Ormet Submits Draft FS through Detailed Evaluation of Alternatives	4/30/91
20 Business Days from Agencies' receipt of Draft FS	Project Review Meeting	5/29/91
20 Business Days from Project Review Meeting	Ormet Submits Final FS	6/25/91
60 Calendar Days from Final FS	Public Comment Period	6/25/91 to 8/25/91
30 Calendar Days from End of Comment Period	ROD Issued	9/30/91

K088

LISTING BACKGROUND DOCUMENT

PRIMARY ALUMINUM REDUCTION

Spent potliners from primary aluminum reduction (T)

I. SUMMARY OF BASIS FOR LISTING

Primary aluminum metal is produced by the electrolytic reduction of alumina, an aluminum oxide. This process takes place in carbon-lined cast iron electrolytic cells known as "pots". After continued use, the carbon pot lining ("potliner") cracks, and must be removed and replaced with a new liner.

The Administrator has determined that these used potliners ("spent potliners") are a solid waste which may pose a substantial present or potential hazard to human health or the environment when improperly transported, treated, stored, disposed of or otherwise managed, and, therefore, should be subject to appropriate management requirements under Subtitle C of RCRA. This conclusion is based on the following considerations:

1. Spent potliners from primary aluminum reduction contain significant amounts of iron cyanide complexes. EPA has detected iron cyanide complexes (expressed as cyanides) in spent potliners in significant concentrations.

Note: The Agency is aware that there are other solid wastes generated by the primary aluminum reduction process, and is currently investigating these wastes to determine whether to list them as hazardous in the future.

2. The aluminum reduction industry typically either stores spent potliners in unprotected piles outside (prior to reprocessing) or dumps them in the open. Part or all of the cyanide contained in the spent potliners can be expected to be released into the environment if spent potliners are dumped in the open, stored without protection in the open or otherwise improperly managed. Available data indicates that significant amounts of free cyanide and iron cyanide will leach from potliners if the spent potliners are stored or disposed of in unprotected piles out-of-doors and exposed to rainwater. In addition, in the presence of sunlight, the iron cyanides may decompose to release highly toxic hydrogen cyanide into the environment. Iron cyanide complexes are toxic and free cyanide is extremely toxic to both humans and aquatic life if ingested.

3. One major damage incident has been reported which is attributable to the improper disposal of spent potliners, demonstrating migration, mobility and persistence of waste constituents, and demonstrating as well that substantial hazard can result from improper management of this waste.

4. In 1977, the primary aluminum reduction industry generated an estimated 191,000 MT of spent potliners per year (approximately 6,366 MT per average-sized plant). This figure is expected to increase to 243,000 MT (approximately 8,100 MT per plant) by 1983. Generation of such large quantities of waste increases the potential for hazard if mismanagment should occur and is a further justification for listing these wastes as hazardous.

II. SOURCES OF THE WASTE AND TYPICAL DISPOSAL PRACTICES

A. Profile of the Aluminum Reduction Industry

Primary aluminum plants convert aluminum oxides into aluminum metal. Currently, there are 30* primary aluminum plants, located in 16 states, operating in the United States.

The primary aluminum industry currently produces approximately 5 million MT of primary aluminum per year (100,000 to 150,000 tons per year for an average-size plant). Pro-

*One other plant operates on a stand-by basis.

duction has been increasing for many years and is expected to reach 7 million MT per year by 1985.(7)

B. Manufacturing Process

Aluminum metal is produced almost entirely by the Hall-Heroult process. In this process, alumina, an aluminum oxide is reduced to aluminum metal in carbon-lined cast iron electrolytic cells known as "pots". The carbon potlining ("potliner") acts as the cathode of the cell; petroleum coke and pitch act as the anode; and cryolite, calcium fluoride, and aluminum fluoride are used as the electrolyte. When an electric current is passed through the pots, the alumina is reduced to aluminum metal. The molten aluminum is periodically drawn off as it accumulates in the bottom of the pots.

During the reduction process, iron cyanide complexes form in the potliners. The chemical/physical mechanism by which these compounds are produced is poorly understood(4); however, it is generally agreed that the iron cyanide compounds are produced in all cases(7).

C. Waste Generation and Management

After continued use, potliners crack, causing the molten aluminum in the pots to become contaminated with iron from the cast iron pots. At this point, the cracked potliners ("spent potliners") must be removed from the pots and replaced with new carbon potliners(1).

In 1974, the primary aluminum industry generated approximately 159,000 MT of spent potliners (approximately 5,300 MT for an average sized plant). By 1977, the industry is generating an estimated [illegible] MT of spent potliners per year (6,366 MT per average facility)(1). This figure is expected to increase to 243,000 MT by 1983(1).

Spent potliners are either processed to recover cryolite (which saturates the potliners during the reduction process)*/ or disposed of immediately.(1,7) Those spent potliners which are reprocessed are usually stored on-site out-of-doors in uncovered piles(1,3,4,7), sometimes for periods of up to five years or more before reprocessing.(7) Spent potliners which are disposed of immediately are generally dumped in the open, either off-site or on-site.(1,3,4,7) No site preparation other than tree and shrub removal is commonly practiced(7). One company also has been reported to dispose of spent potliners in a lagoon, along with industrial sludge.(7)

D. <u>Hazardous Properties of Spent Potliners</u>

Spent potliners contain iron cyanide complexes. As noted above in Section B, these complexed cyanides are generated during the reduction process, and are believed to be present in all spent potliners. Analyses of leachate from piles of spent potliners (discussed below) confirm the presence of iron cyanide and free cyanide in the spent potliners(2,3,4,5). These concentrations are indicative of a potential for hazard, since these complexed cyanides are capable of migration as highly toxic free cyanides. Furthermore, iron cyanides themselves are toxic.

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*/The Agency has information indicating that the wastewater from the cryolite recovery process contains high concentrations of cyanide. This waste stream is, therefore, being considered by the Agency as a candidate for future listing. Further information is solicited.

The following discussion demonstrates that cyanides are present in these wastes in substantial concentrations, and that, if the wastes are mismanaged, cyanide may migrate as both free and complexed cyanide, and may be mobile and presistent enough to reach environmental receptors via groundwater, surface water and air exposure pathways in concentrations sufficient to create a substantial hazard. Indeed, one damage incident involving spent potliners confirms that these wastes can cause substantial hazard if mismanaged.

A. <u>Waste Composition and Migratory Potential of Waste Constituents</u>

The Agency does not presently possess reliable data on iron cyanide concentrations in spent potliners themselves, but concludes that the concentrations of cyanide in potliners are substantial, based on cyanide concentrations in leachate from potliners. These data further demonstrate that the iron cyanide in the waste may migrate as highly toxic free cyanide in high concentrations in leachate or surface runoff. Monitoring samples taken by Kaiser Aluminum and Chemical Company in 1976 (10) confirm that free cyanide may migrate from this waste in high concentrations upon exposure to leaching media. These data indicate 2500 mg/l of free cyanide (13,000 mg/l total cyanide) in potlining slab liquor samples (the runoff from concrete slabs on which spent potliners are placed during open storage), and 1200 mg/l free cyanide (9000 mg/l total cyanide) in pot soaking pit liquor sample (liquor left after spraying pots to facilitate removal of the liner.

That these concentrations pose very high potential for hazard is indicated by the fact that exposure to 300 ppm of cyanide will cause death to humans in minutes (see p. 9 below).

Furthermore, in a paper entitled "Development of a Method for Detoxificaiton of Spent Cathode (potliner) Leachates", Comalco Aluminum personnel stated, " The storm water leachate from spent reduction cell cathodes (spent potliners) stored uncovered in the open typically contains unacceptably high levels of cyandies."(4). Table 1 of this paper shows spent potliner leachate to contain 200 mg/1 */ of free cyanide and 2000 mg/1 complexed cyanides prior to leachate treatment.

A third source likewise identifies substantial concentrations of complexed cyanides in leachate from spent potliners. The Kaiser Aluminum and Chemical Company collected and analyzed samples of pondwater from a pond that collects rainwater runoff from spent potliners which are discarded in a 10-acre dump next to its Chalmette, LA plant. Kaiser reported that pond liquor contains complexed cyanide in concentrations ranging from 50-700 ppm.(3,9) The chemical analyses of the pond liquor samples show concentrations of 100-350 ppm cyanide.(9)

Thus, both extremely toxic free cyanide and less toxic iron cyanides are capable of migrating from spent potliners in

*/The table, in fact, does not give units of measurement, but the actual values indicate that the units are mg/1.

substantial concentrations if the waste is exposed to leaching media. Migration of free cyanides may also occur via an airborne route. Iron cyanide has long been known to undergo photodecomposition leaving extremely toxic hydrogen cyanide and free cyanide decomposition byproducts.(8,13,14,15,16)*/ Hydrogen cyanide will then enter the atmosphere, where it is both mobile and persistent.(17) **/

Once free cyanide migrates from the waste it is likely to be quite mobile in soils. Cyanide has been shown to move through soils into groundwater.(12) Disposal of these wastes in the open, a present waste management method, could therefore lead to release of free cyanides and subsequent migration through soils to groundwater. (Migrating iron cyanide, on the other hand, has limited mobility in soils, but, as shown above, can photolyse to form mobile cyanide and hydrogen cyanide.)

Thus, these wastes may potentially release high concentrations of cyanide into water and (to a lesser extent) air, should mismanagement occur. Current waste management practices appear to allow a strong possibility of migration of cyanide i.e., spent potliners are often simply dumped in the open. Spent potliners being stored for cryolite recovery are also piled in the open without cover, sometimes for periods of up to five years (see p. 4 above). The Agency believes that substantial hazard could result from these

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*/These sources do not indicate a degradation rate constant.

**/Hydrogen cyanide is reported to be resistant to naturally occuring wavelengths reaching the earth's surface.(17)

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types of waste management practices, in light of this waste's potential to release free cyanide, and cyanide's mobility and persistence following release.

An actual damage incident involving spent potliners confirms this judgement. Kaiser Aluminum's Mead Works is situated 150 feet above the Spokane aquifier which is used for private wells and which drains into the Little Spokane River.(5) Leachate from a lagoon containing potliners and sludge leached through the ground and contaminated the aquifier with cyanide.(5) Eighteen wells were contaminated, some having cyanide levels in excess of 1,000 ppb.(5) Kaiser had to provide alternative sources of drinking water to the affected owners and to upgrade and seal the leaking lagoon.(5)

A further reason for listing spent potliners as hazardous is the quantity of waste generated. Approximately 191,000 MT of spent potliners were generated by the aluminum industry in 1977 and this figure is expected to increase substantially (see p. 3). Thus, large amounts of cyanide are available (in light of the high concentrations in leachate) for environmental release. These large quantities pose the danger of polluting large expanses of ground and surface waters, and an increased likelihood of reaching environmental receptors, in light of cyanide's mobility in water and air. Contamination also could occur for long periods of time, since large amounts of pollutants are available for environmental loading. Attenuative capacity of the environment could also be reduced or exhausted by large quantities of pollutants released from the waste. All of these considerations increase the possibility of exposure to harmful constituents in the waste and; in the Agency's point of view, further justify a "T" listing.

Hazards Posed by Harmful Constituents

Cyanide is extremely toxic when it is ingested in free form and less toxic when ingested in complex form. (Appendix A). Free cyanide can cause death in humans and aquatic life. In its most toxic form, cyanide can be fatal to humans in a few minutes at a concentration of 300 ppm. While recovery from non-fatal poisonings is generally rapid and complete, fatal exposure levels are low. (App. A)

The Public Health Service recommends 0.2 mg/l as the acceptable level of cyanide for water supplies and EPA has recommended that this level be used as the ambient water quality standard under the Clean Water Act. The Canadian government has set a similar criterion. OSHA has regulated exposure levels for the workplace. Finally, final or proposed regulations of the states of California, Maine, Maryland, Massachusetts, Minnesota, Missouri, New Mexico and Oregon define cyanide-containing compounds as hazardous waste or components thereof. See Appendix A for references and additional information on cyanide.

Response to Comments

On August 22, 1979, EPA proposed to list spent potliners as a hazardous waste (44 FR 49404). No information was submitted during the public comment period that disagreed with the conclusion that spent potliners are hazardous as defined by the proposed regulation. The Anaconda Company stated however, that the particular disposal practices, coupled with the physical and geologic conditions at its two primary aluminum smelters produce "no significant release of any constituent from the spent potliners into an underground water supply." (5). Anaconda indicates that coal (not water) underlies its Kentucky disposal site, that there is little rain at its Montana site. It concludes that the standards for each disposal site should be established separately.

The conditions at any particular disposal site do not, however, change the initial determination of whether or not a waste is hazardous. A waste is listed as hazardous if it may pose a substantial threat to human health and the environment if it is mismanaged. Anaconda implicitly concedes that if the constituents released from spent potliners entered a drinking water reservoir, such a threat would exist. The individual circumstances of a particular disposal site will be addressed when a permit is issued, and are otherwise taken into account in many of the standards contained in the recently promulgated Parts 264 and 265 (see, e.g., §265.90(c), which provides for a waiver of the groundwater monitoring requirement if a facility owner/operator demonstrates "that there is a low potential for migration of hazardous waste or hazardous waste constituents from the facility via the uppermost aquifer to water supply wells ... or to surface water").

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PGR-6-71 May 26, 1971

Project Group Report

Chemical Services

EFFECTS OF CHLORINE AND CALCIUM ON CRYOLITE PLANT POND WATER

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Metallurgical & Chemical Services
Hannibal, Ohio

Effects of Chlorine and Calcium on Cryolite Plant Pond Water

Summary

A series of Cryolite Plant pond water samples were treated with varying amounts of free chlorine. They were then analyzed to determine the concentration of free cyanide. Addition of about 200 ppm free chlorine lowers the free cyanide below the limit of detection (less than .02 ppm).

Similarly, addition of calcium, as calcium hypochlorite solution or lime slurry, reduced the fluoride content to about 400 ppm and did not affect the cyanide removal.

Introduction

The classical method of neutralizing industrial cyanide wastes is by treatment with chlorine in alkaline solution. The chemical reactions are as follows:

(1) $NaCN + 2NaOH + Cl_2 \longrightarrow NaOCN + 2NaCl + H_2O$
(2) $2NaOCN + 4NaOH + 3Cl_2 \longrightarrow 2CO_2 + 6NaCl + N_2 + 2H_2O$

Before construction of our Cryolite Recovery Plant, the Potroom scrubbers utilized a "calcium system" -- lime slurry was used to neutralize the scrubber stream and precipitate scrubbed fluorides, such as calcium fluoride, by the following chemical reactions:

(3) $2NaF + Ca(OH)_2 \longrightarrow CaF_2 + 2NaOH$
(4) $2HF + Ca(OH)_2 \longrightarrow CaF_2 + 2H_2O$

The Cryolite Plant pond, at its pH of about 12, should follow reactions 1, 2 and 3.

Experimental

Free chlorine in aqueous solution was prepared by mixing calcium hypochlorite ($Ca(ClO)_2$) with deionized water and decanting the solution from the remaining residue. The chlorine solution was standardized immediately before use with sodium thiosulfate ($Na_2S_2O_3 \cdot 5H_2O$) to determine available chlorine (per ASTM D1291-57). After measured amounts of chlorine solution were added to samples of pond water, they were analyzed for free cyanide. The effect of free chlorine $(Cl_2)^o$ on free cyanide $(CN)^-$ is indicated in Figure 1.

The calcium hypochlorite treated samples were then analyzed for fluoride content. Several other groups of samples were treated with lime slurry (10%Ca^{++}) and were agitated for varying lengths of time from four (4) hours up to three (3) days, followed by fluoride analysis. The effect of calcium on fluoride is indicated in Figure 2. The amounts of calcium listed are the concentrations of total calcium available in the solution rather than the dissolved calcium. The longer periods of agitation did not decrease the fluoride concentration.

A set of samples were treated with lime slurry and then neutralized to pH7. Fluoride levels remained consistent with the previous tests.

A number of samples previously treated with lime slurry were then chlorine treated and analyzed for cyanide. Cyanide results were similar to samples without lime slurry.

Conclusions

1. Treatment of the Cryolite Plant pond water with chlorine will remove free cyanide. 200 ppm added and thoroughly mixed without sunlight, preferably in the evening, should solve the problem.
2. Treatment of the pond with calcium hypochlorite or lime slurry will reduce but not completely remove the fluorides. Neutralization may be desirable for other purposes, but it does not enhance fluoride removal.
3. Calcium content or neutralization will not inhibit cyanide removal by chlorination.

FIGURE 2

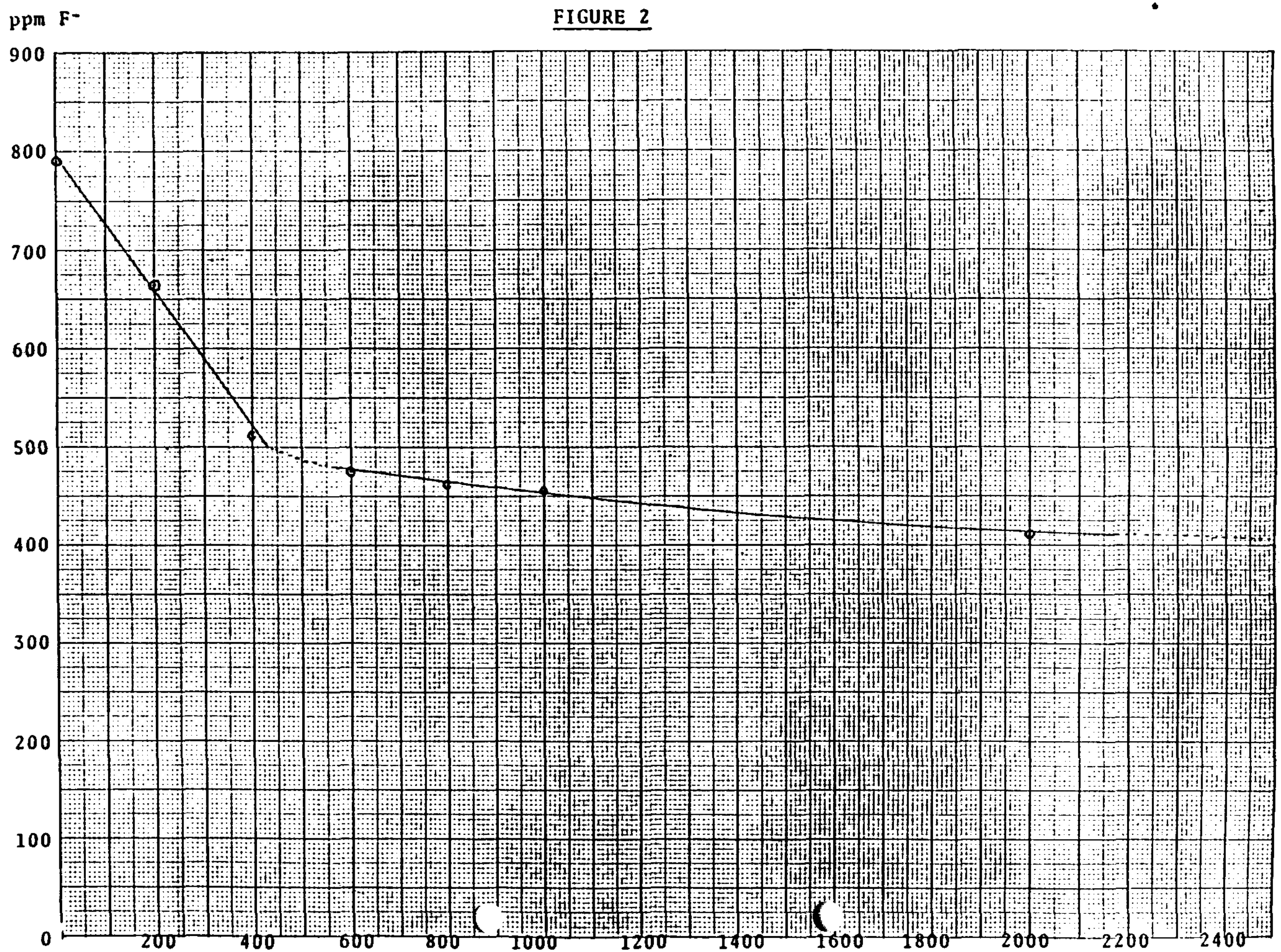
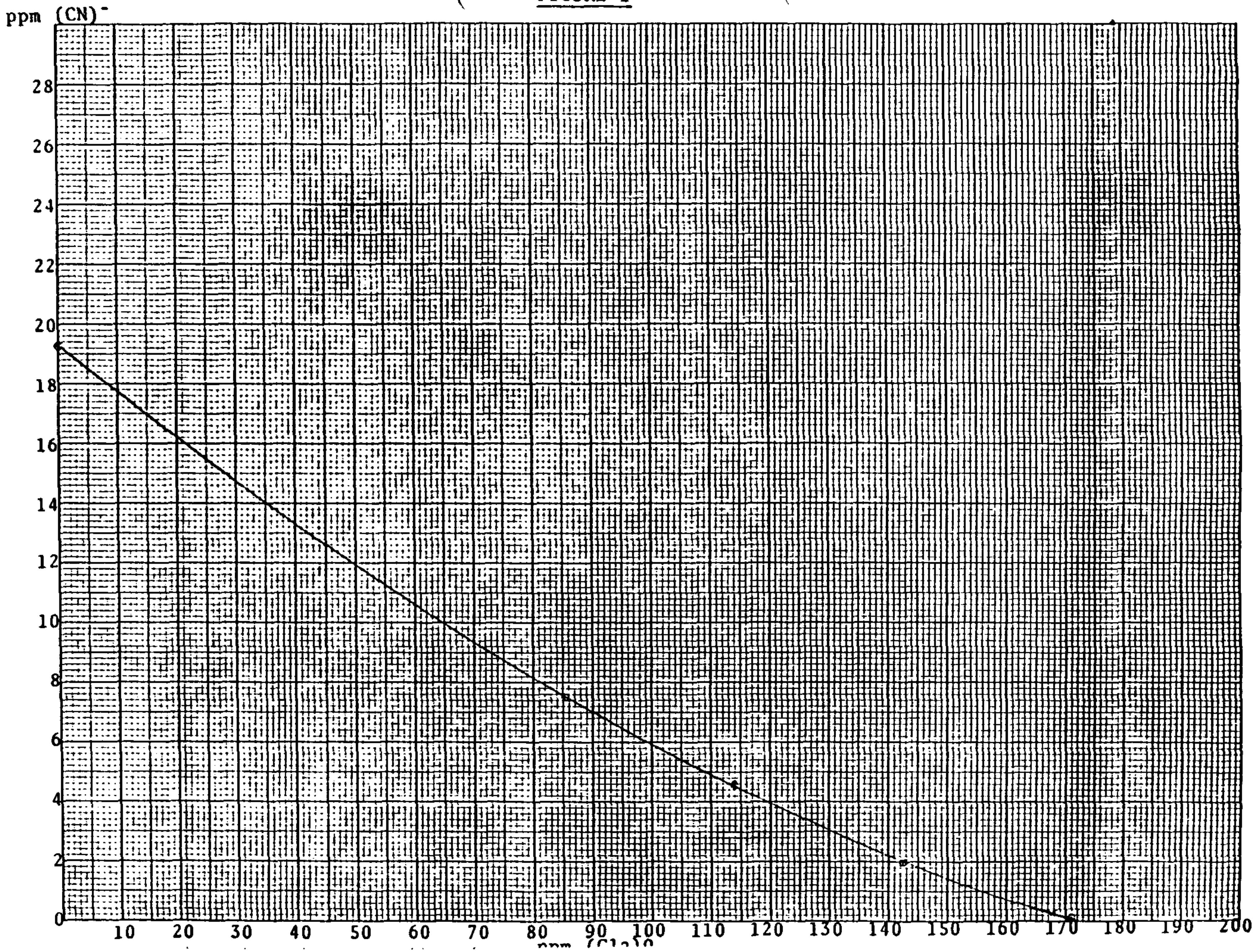

ppm F⁻
900
800
700
600
500
400
300
200
100
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400

FIGURE 1


ppm (CN)-
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200

Ormet Corporation
18.21 s

EASEMENT

TRACT 407E

ALL THAT CERTAIN TRACT of land situated partly in Sections 8, 9, and 14, Township T-2, Range 3 in the Township of Ohio, and partly in Section 10, Township T-2, Range 3 in the Township of Salem, County of Monroe, State of Ohio, and being more particularly bounded and described as follows:

BEGINNING at a point on the right bank of the Ohio River at elevation 626 feet mean sea level on the dividing line between the lands of Ormet Corporation, and lands now or formerly of Olin Mathieson Chemical Corporation, said point being located North 80° 16' East 3803 feet, more or less, from the centerline of the Pennsylvania Railroad which crosses over Muhleman Run, and further located South 42° 17' East 2730 feet, more or less, from Corps of Engineers Survey Station H.R. 1/21;

THENCE through the lands of Ormet Corporation by the meanders of the contour ~~at~~ elevation 626 upstream in a northeasterly direction approximately 2720 feet (closing chord: (1) North 70° 16' East 2444 feet more or less) to the downstream end of a dock;

THENCE along the river side of said dock by the meanders of said contour approximately 230 feet (closing chord: (2) North 60° 05' East 207 feet, more or less) to a point on the upstream end of said dock;

THENCE continuing through the lands of Ormet Corporation by the meanders of said contour upstream in a northeasterly and northwesterly direction approximately 9470 feet (closing chords: North (3) 45° 46' East 525 feet, (4) North 11° 31' West 391 feet, (5) South 24° 23' East 318 feet, (6) North 29° 42' East 2416 feet, (7) North 62° 51' West 565 feet, (8) South 82° 21' East 563 feet, (9) North 15° 10' West crossing the dividing line between Ohio Township and Salem Township at 3113 feet, in all 3923 feet, all being more or less) to a point on the dividing line between the lands of Ormet Corporation, and lands now or formerly of the Pennsylvania Railroad Company;

THENCE with said dividing line (10) South 79° 49' East 45 feet, more or less, to a point at elevation 615;

THENCE by the meanders of the contour at elevation 615 which represents the existing ordinary high water stage in this reach of the Ohio River, downstream in a southeasterly and southwesterly direction approximately 8090 feet (closing chords (11) South 27° 36' East crossing the dividing line between said Salem Township and Ohio Township at 810 feet, in all 2001 feet, South (12) 06° 07' West 3303 feet, (13) South 40° 41' West 1939 feet, all being more or less) to a point on the upstream end of the aforementioned dock;

THENCE along the river side of said dock by the meanders of the 615 foot contour approximately 220 feet (closing chord: (14) South 58° 59' West 214 feet, more or less) to a point on the downstream end of said dock;

THENCE continuing through the lands of Ormet Corporation by the meanders of the 615 foot contour downstream in a southwesterly direction approximately 2500 feet (closing chord: (15) South 69° 15' West 2445 feet, more or less) to a point on the aforementioned dividing line between Ormet Corporation, and lands of said Olin Mathieson Chemical Corporation;

THENCE leaving said contour, with said dividing line (16) North 20° 59' West 59 feet, more or less, to the point of BEGINNING.

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Exhibit B-3

HYDROGEOLOGICAL SURVEY OF

PLANT WATER SUPPLY - 1972

For

THE ORMET CORPORATION
ALUMINUM REDUCTION DIVISION
HANNIBAL, OHIO

By

FRED H. KLAER, JR. AND ASSOCIATES
CONSULTING GEOLOGISTS AND HYDROLOGISTS
COLUMBUS, OHIO

March 1, 1972

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SYNOPSIS

INTRODUCTION:

The Hannibal plant of the Ormet Corporation went into operation in 1957. This is an aluminum reduction plant, producing metallic aluminum from aluminum ore, bauxite. The Ormet plant and the adjacent Omal plant are supplied with water from two radial wells or "Ranney wells" located on the west bank of the Ohio River about 2100 feet apart.

In July and August 1971, it was noticed that the water from the Ormet Ranney well, the upstream well, was discolored and contained high fluorides. Difficulty was experienced also in using the water for cooling rectifiers in the Ormet plant. It is reported that the appearance of the color developed rather suddenly within a period of about one month.

During the summer of 1971, seepage of a black water occurred on the east side of the levee forming the east side of the disposal pond, which drained into the recreational area. Attempts to seal off the seepage by injecting cement grout into the levee were unsuccessful.

Shortly prior to the appearance of colored water in the Ranney well, the corporation had purchased a large amount of pot liner from a competitor, which was stored near the north end of the present disposal pit. Although no significant chemical difference could be found between the Ormet pot liner and the purchased pot liner material, it was thought that the purchased pot liner material was the source of the color contaminant.

In December 1971, after a discussion of the problem, the Ormet Corporation retained Fred H. Klaer, Jr. and Associates of Columbus, Ohio, to make a detailed hydrogeological survey "to determine the geologic and hydrologic conditions between the radial well and the pot liner storage and disposal pit area; the point or area of entry of a colored pollutant into the sand and gravel aquifer supplying water to the radial well and to recommend means of controlling the movement of the pollutant by hydraulic or other methods". The work was authorized by Ormet Purchase Order No. OH-69952 dated December 6, 1971.

WORK PERFORMED:

A total of twelve 6-inch test holes or monitor wells and one 8-inch well (to be pumped) were drilled for a total footage of 903.5 feet of 6 inch drilling and 92 feet of 8 inch drilling. The drilling was done by the Ohio Valley Testing Laboratory using power auger methods. Because of the heavy fill and caving conditions, the power auger methods used were not successful in sinking the test holes to the desired depths and a standard cable tool well drilling rig was brought in to complete the holes. The low static water level and the use of a cable tool drilling rig made it necessary to add water from the sanitary water system (provided by the Omal Ranney well) to the test holes in order to remove the materials from the well by bailing.

Samples of water for chemical analyses were obtained by bailing during the drilling process and later by air-lift methods using s small portable air compressor. The low static water levels in several of the test holes did not permit adequate submergence to pump water by air-lift methods and a special air operated sampler was used. In using all the methods described above, only small quantities of water were removed from the wells during sampling and it was not certain that the samples obtained were truly representative of the water in the aquifer unaffected by the sanitary water added during the drilling.

The water samples obtained from several test holes by the three methods used showed large variations in pH, fluoride content, color and percent of transmittances, raising a question as to the validity of the samples. A small submersible deep well pump was purchased by Ormet and a complete set of samples from all test holes except

Test Holes 7 and 10 were obtained by pumping at rates of 2 to 5 gpm for ½ hour and 1 hour periods. It is our opinion that samples obtained by pumping are more representative of the true quality of water in the aquifer.

The test holes or monitor wells were left in place to permit additional sampling for chemical analyses, as may be required, and to serve as observation wells for water level observations.

All chemical analyses were made by the personnel of the Ormet chemical laboratory.

ACKNOWLEDGEMENTS:

The detailed study described in the following report has been in a sense a cooperative venture, in that the study could not have been made without the full cooperation and assistance of many of the engineering and chemical personnel of the Ormet Corporation, whose help is gratefully acknowledged. Special thanks should go to Mr. Bernard Paidock, Project Engineer, who acted as liason between Ormet and the consultants.

SUMMARY AND CONCLUSIONS:

In order to facilitate a review of the results of the study, the Summary and Conclusions are presented here and are followed by the Report in which the basis for these conclusions are discussed in more detail.

1. The Ormet and Omal plants are situated on a broad alluvial terrace along the west bank of the Ohio River that is underlain by a sand and gravel deposit, the lower 30 to 40 feet of which is saturated and which constitutes an aquifer or ground water reservoir. The underlying bedrock surface is relatively flat at an elevation of 560 to 565 feet above mean sea level (MSL) for a distance of about 1000 feet back from the river. The upper

surface of the aquifer is covered in places by natural and artificial fill, in places by fine grained deposits of clay and silt and in other places the sand and gravel is exposed at the surface.

2. The aquifer is replenished or recharged by water from precipitation on the alluvial terrace, by surface wash draining from the higher ground north of the plants, by induced infiltration from the Ohio River caused by pumping the Ranney wells, and by leakage from the disposal pits. The ground water reservoir is depleted by natural drainage into the Ohio River and by pumping from the Ranney wells.

   The estimated storage capacity of the ground water reservoir is about 1,080 million gallons, which with no recharge or replenishment would be pumped out at an average rate of 6 million gallons per (MGD) from the two Ranney wells in about 180 days. The total amount of water stored in the aquifer is only 3.5 percent of the total volume of water pumped from the aquifer during the past 15 years. Since the aquifer has not been emptied, more than 97 percent of the water pumped has been from recharge or induced infiltration.

3. The pumping of the Ormet Ranney well has created a cone of depression that probably extends to the bedrock valley walls on both sides of the river and which now extends about 7000 feet upstream under the disposal pond area. Because of the reduced capacity of the Ranney well, it is our opinion that the infiltration rate through the river bottom has decreased since the Ranney wells were installed.

4. The results of a pumping test on the 8 inch pumped well showed that the coefficient of transmissibility was about 60,000 gallons per day per foot, the coefficient of permeability was about 1900 gallons per day per square foot and the coefficient of storage was about 0.19. These parameters were used to compute the apparent cone of depression caused by the pumping of the Ormet Ranney well.

5. The Ormet plant has been discharging a waste slurry into several disposal ponds at a rate of about 100 gpm for many years. At least three such ponds have been filled and abandoned and the fourth disposal pond is now in use. We estimate that the slurry is about 80 percent water or 80 gpm. Evaporation losses are estimated as about 11 percent of the total water disposed. This leaves about 71 gpm or 102,000 gpd or about 37 million gallons per year that must leave the disposal pond by percolation and seepage, since there is no surface outflow.

6. The effluent being pumped into the disposal pond from the cryolite recovery plant and the pot room gas scrubber system has a pH of 10.5 to 11.7, and a fluoride content of about 1000 to 1350 ppm. The water is colored, but not as highly colored as the water pumped from several of the test holes. It is reported that the color is due to about 95 percent organic material; that is in part colloidal and will settle out on standing, by changing the pH, and by heating. The effluent has a high causticity and can react with natural earth materials, particularly organic matter.

7. Water samples obtained from the test holes by bailer and air lift methods showed considerable variation in chemical quality, possibly due to water added during the cable tool drilling. Samples pumped with a deep well submersible pump are believed to be more representative of the true quality of ground water.

8. Water samples from the test holes showed that an elongated area of black water extends around the present disposal pond and westward to T.H. 3, excluding T.H. 4 and T.H. 6. High pH values were found in the same general area, including T.H. 6. The highest fluoride contents were found in T.H. 5, T,H. 6, T.H. 8, T.H. 3 and the 8 inch pumped well. We believe this indicates an extensive zone in which the water in the aquifer has been contaminated

by seepage from the abandoned and present disposal ponds.

9. The low pH, fluoride content, and color of water from T.H. 10 and T.H. 11 in the pot liner storage area, suggest only slight contamination. Observations of standing water over long periods of time in the pot liner storage area suggest low permeability of the surficial soils. It is our opinion that the leachates from the pot liner storage areas are not primarily responsible for the contamination.

10. We believe that the continual slow seepage of about 70 gpm of effluent from the disposal ponds through the accumulated solids in the disposal ponds and the possibilities of chemical reactions with longer periods of contact time are mainly responsible for the development of the black color in the water pumped from the test holes.

11. It has been reported that the pot room gas scrubber system was changed from a calcium system to a sodium system in 1968, and that the now abandoned disposal ponds were used until February and May, 1969. Such a change presumably would increase the solubilities of the wastes and permit travel through the aquifer.

12. Estimates of the time required for a particle of water to move from disposal ponds to the Ranney well were made by computing the approximate ground water velocities through 500 foot intervals of distance at average ground water gradients. Travel time from the abandoned disposal pit A, about 2100 feet from the Ranney well is estimated as about 630 days or 1.7 years, and from the present disposal pit, at a distance of about 3000 feet is estimated to be about 1386 days or 3.8 years. These computed times although not precise, may explain why the colored water did not show up in the Ranney well until July, 1972.

Because of the slow drainage from the disposal pits, the abandoned disposal pits may still be contributing contamination to the aquifer, causing dark color, high fluoride and high pH in T.H. 3.

13. We believe that the study has shown that the continued pumping of the effluent into disposal ponds has resulted in the loss by underground seepage to the aquifer of about 70 gpm of highly contaminated water, which if not intercepted by the Ranney well will ultimately drain into the Ohio River. We recommend strongly that consideration be given to possible treatment of the effluent before disposal to remove the color forming compounds and the high fluoride content. We also suggest consideration of a possible change in the system used in the pot room gas scrubber system, to minimize the contaminants in the effluent.

14. It is our opinion that the flow of contaminated water from the disposal pond area to the Ranney well can be intercepted or diverted by a hydraulic barrier system. A hydraulic barrier can be created by injecting water into the aquifer and raising the water level in a ridge-like elongated hump in the water table. Such injection is referred to as a positive barrier. A negative barrier can be pumping from several wells, lowering the water level in a trough like depression of some length. The feasibility of either type of hydraulic barrier will depend in large part on the availability of clean water for injection, the practicality of treating the contaminated water pumped, the relative costs of properly designed and constructed wells, interconnecting pipelines and other pipelines either to the source of water or to the point of disposal and many other factors. It may be necessary to actually try a hydraulic barrier on a pilot plant basis to assure success.

15. A hydraulic barrier of either type should be located along a north-south line about along range line W 4000, between the abandoned disposal pits and the Ranney well. It should consist of at least three wells spaced about 500 feet apart. The injection or pumping of 200 gpm from each well should raise or lower the water level at least 4.4 feet or more over a linear distance of about 1500 feet. This we believe should be adequate to divert the flow of water away from the Ranney well or to intercept the contaminated water for treatment. Several additional monitor wells will be needed to check the success of the barrier system.

16. The use of a positive barrier requires a source of sediment-free water which presumably would have to come from the Ohio River. This will require treatment facilites for coagulation, sedimentation and chlorination. Such water would have to mix with the contaminated water without forming precipitates.

    A positive barrier system will add water to the system and the contaminated water will be diverted presumably to drain into the Ohio River. The injection of river water may raise the temperature of the Ranney well water in summer and decrease the temperature in the winter with some time lag. The injection wells probably will have to be pumped occassionally to remove any accumulated sediment carried into the wells.

17. The use of a negative barrier system will create an elongated cone of depression along a distance of about 1500 feet or more that will intercept the flow of contaminated water, pumping it out to the surface where it can possibly be treated for reuse or for disposal into the river, if such treatment can be accomplished. A negative barrier will probably decrease the capacity of the Ranney well to some extent, which may be offset by the water pumped for reuse. The removal of contaminated water from the disposal

pond area will assist in ultimately cleaning up the contaminated area, although this may require many years. We believe that the use of a negative barrier will be more economical because of less supervision and maintenance required than a positive barrier system.

18. The actual costs of either type of hydraulic barrier system are difficult to estimate at this time because they depend on the relative costs of treatment of injected and pumped water. In either case, the wells should be overdesigned to inject or pump larger quantities of water if necessary when the river stage is raised 21 feet. We believe the costs of the systems without treatment costs included would be in the order of magnitude of perhaps $100,000 to $150,000.

19. The closing of the Hannibal Locks and Dam scheduled for late 1973 will raise the normal pool stage 21 feet to elevation 623 feet MSL. The flow of the same quantity of river water through a larger cross-sectional area will decrease the velocity of flow and may increase the silting of the river bottom.

It is our opinion that the rise in river will raise the ground water levels in the disposal pond area, but will have little effect in increasing or decreasing the contamination from the disposal pond.

The increased head on the river bottom will probably increase the infiltration rate, increasing the capacity of the Ranney well. Because of the already decreased infiltration rate the full effect of the river rise may not be reflected in the Ranney well. As increased silting occurs due to the slower river velocities, the infiltration rate may decrease and pumping levels in the Ranney well may decline over a period of time.

Because of the uncertain effects of the rise in river stage, we have recommended overdesign of the hydraulic barrier wells to permit changing water levels to a greater degree than at the present time.

Respectfully submitted,

FRED H. KLAER, JR. AND ASSOCIATES
Consulting Ground-Water Geologists
and Hydrologists

by Fred H. Klaer Jr.
Fred H. Klaer, Jr.
Certified Professional Geologist No. 75
Registered Geologist (California) No. 1798

FHKJr:eh

x

REPORT

GEOLOGIC CONDITIONS:

The Ormet and Omal plants are located on a broad alluvial terrace along the west bank of the Ohio River between about River Miles 122 and 124.4, known as Buck Hill Bottom, in Ohio Township, Monroe County, Ohio. The general plant level is about 665 feet above mean sea level (MSL) and the present normal pool stage, controlled by Dam 15, is at elevation 602.2 MSL. The alluvial terrace is about 4 miles long, is about ½ mile wide at its widest point and pinches out against the bedrock wall of the valley at both ends.

The bedrock formations along the north side of the terrace and underlying the alluvial materials are shales, sandstones, and coals of the Dunkard series of Permian Age, which are basically non-waterbearing. Surface water draining off the steep hillsides apparently seeps into the alluvial terrace materials along the north side of the plant property. Such water and perhaps as small amount of water draining from the bedrock formations maintain high water levels in the alluvial formations near Test Holes 10 and 11. The amount of water contributed to the aquifer from this source is estimated to be less than ten percent of the water pumped from the Ranney wells.

The bedrock surface underlying the alluvial terrace is about at elevation 555 to 560 feet MSL along the river front near the Ormet Ranney well and slopes gently up in a landward direction away from the river. In T.H. 11 about 1800 feet inland, the bedrock is at elevation 602.feet MSL. North of State Route 7, the bedrock is believed to rise rapidly to elevations above 700 feet MSL.

The earth materials underlying the present plant are of three general types. Much of the plant area within about 1000 feet of the river has been raised to its present elevation by as much as 30 feet of fill material, generally obtained from the hillside north of the plant. In many places, the surficial soils or fill material is underlain by fine grained materials such as clays, sandy and silty clays, or fine sands containing silt. In other places, the fill may lie directly on sand and gravel and in many areas the sand and gravel may be found directly below the surface.

The character of the fine grained materials as seen in the field and described in various soils reports varies within wide limits from true clays that appear to be quite impermeable to mixtures of sand and silt that are semi-permeable, but that probably would permit the slow seepage of water from rainfall through the fine grained materials to the underlying aquifer.

The alluvial sand and gravel deposits comprising the major part of the alluvial terrace are generally fairly clean, medium to coarse in grain size and fairly thick ranging from perhaps 20 feet to as much as 80 to 100 feet. In the vicinity of the Ranney well, prior to pumping, only the lower 40 feet of sand and gravel was saturated.

The locations of the test holes drilled during the study as well as the locations of RTH-3, RTH-8, and RTH-9 of the original Ranney survey are shown in Figure 1 and their logs are shown in Figure 2.

The water-bearing deposit of sand and gravel or aquifer is in reality a large underground reservoir, which is replenished or recharged by precipitation falling on the surface, by a small amount of surface water draining southward from the high ground north of the plant, by induced infiltration from the Ohio River caused by the lowering of water levels due to pumping of the Ranney wells, and possibly by drainage of water from the disposal pits. The reservoir is depleted by natural drainage into the Ohio River and by pumping from the Ranney wells.

The approximate area of the alluvial terrace was measured by planimeter as about 24 million square feet. Assuming an average daily pumpage from the two Ranney wells of about 6 million gallons a day, the water stored in the aquifer would be pumped out in about 180 days, assuming no recharge to the aquifer. The total amount of water originally stored in the aquifer amounts to only 3.3 percent of the total amount of water pumped from the two Ranney wells during the past 15 years of operation. The remaining 96.7 percent has been obtained from recharge from rainfall, seepage into the ground, and we believe mainly from infiltration from the river. Since the water stored in the aquifer was removed mainly during the first few years of pumping it is estimated that the water now being pumped may be as much as 90 percent or more infiltrated river water. The remaining 10 percent is derived from precipitation on the alluvial terrace, from surface wash from the surface drainage basin tributary to the alluvial terrace, and from seepage from the disposal ponds.

HYDROLOGIC CONDITIONS:

Prior to the construction of the plant and the pumping of the Ranney wells, the water table under the alluvial terrace generally sloped toward the river and water falling on the terrace drained naturally into the Ohio River. Since the Ohio River is essentially at the same elevation along the full length of the terrace, water table contours were approximately parallel to the edge of the river.

In 1956, two Ranney wells were constructed with an estimated capacity of about 10 million gallons per day. Pumping tests run prior to construction showed that the apparent coefficients of transmissibility were high and that infiltration from the Ohio River could be induced within relatively short distances from the centers of pumpage. Unfortunately, no detailed pumping test was run at the site of the Ormet Ranney well and the hydraulic parameters of the aquifer at this site were not determined.

When pumping of the Ranney wells was started, the water levels around each Ranney well were lowered in the shape of an inverted cone or cone of depression, the shape of which was controlled by the rate of pumping, the permeability and transmissibility of the aquifer, and the infiltration rate through the river bottom. At first, the development of the cone of depression was symmetrical, but as the cone of depression extended under the river and infiltration was induced from the river, the ground water gradients became steeper toward the river and flatter on the land side, extending the effects of pumping landward to the limits of the aquifer, the bedrock wall of the valley.

On the river side, the spread of the cone of depression was slowed by induced infiltration from the river. However, the rate of infiltration through the river bed has apparently decreased and as it decreased, the cone of depression spread more widely until it hit the bedrock wall on the West Virginia side of the river and then spread up and down river to intercept as much water as possible.

The original basis on which the capacities of the Ranney wells were estimated assumed that the river bottom would be periodically scoured and cleaned by high water; temporary silting would be removed and infiltration rates would be restored. Due to the increasing silt load in the Ohio River, this has apparently not occurred in recent years, and infiltration rates are probably lower than when the wells were built. In 1966, test drilling in the river showed that ground water levels were below river level for as much as about 2200 feet upstream from the Ormet Ranney well.

It is our opinion that the Ranney well still obtains the major part of its water by induced infiltration from the river, but that the cone of depression has spread up and down river to intercept infiltration through a larger infiltration area because of the reduced infiltration rate per unit area. Evidence of infiltration from the river is the annual change in well water temperatures which follow the temperature cycle of the river with a one to two month time lag.

HYDRAULIC PARAMETERS OF THE AQUIFER:

During the original Ranney survey, two detailed pumping tests were run at Site A about 700 feet downstream and at Site C about 2100 feet downstream from the Ormet Ranney well, but no detailed test was run at Site D, the location of the Ormet well. The apparent coefficient of permeability at the Ormet well was estimated as 6000 gpd per sq. ft. This apparent value of permeability was affected by river infiltration, which was high at the time the test was run. The river was 4 to 13 feet above pool stage and the river bottom was relatively clean and permeable. It is our opinion that the true value of permeability of the aquifer, unaffected by river infiltration, was considerably lower.

In order to determine the coefficients of permeability and storage in the general area of the disposal pond, an 8-inch well was drilled about 110 feet south of T.H. 5, and about 470 feet north of T.H. 4. The well was equipped with 15 feet of slotted casing between depths of 72 and 87 feet. A temporary submersible deep well pump was installed in the well and was equipped with a discharge control valve, a 4 inch by 2½ inch free discharge measuring orifice, and a diesel-electric generator set. A multiple step drawdown test was run on January 27,1972, when the well was pumped at rates of 80, 120, 160, and 195 gpm. each rate being held constant for 30 minutes. The purpose of the test was to determine the efficiency of the well and the true drawdown in the aquifer. At a rate of 195 gpm, the total observed drawdown in the well was 12.81 feet and the true aquifer drawdown was 10.09 feet. The efficiency of the well was 81 percent.

Due to a breakdown of mechanical equipment, the constant rate pumping test was delayed until February 8, 1972. The well was pumped continuously at a constant rate of 170 gpm for 24 hours. Static and pumping levels were measured at frequent intervals with an electric tape. Changes in water levels in T.H. 5, 110 feet north of the 8 inch pumping well were measured by automatic water level recorder. A hydrograph of water levels during the constant rate test is shown in Figure 3.

The static water level in the 8 inch well, prior to pumping, was 52.50 feet below the top of the casing or at elevation 601.70 feet MSL, about 0.5 foot below river level. After 24 hours of pumping, the water level in the 8 inch well was 63.32 feet below the top of the casing or at elevation 580.93 feet MSL. The observed drawdown was 10.82 feet, and the true aquifer drawdown was 8.74 feet. In T.H. 5, the pumping of the 8 inch well lowered the water level from an elevation of 602.29 feet MSL to 601.59, giving an observed drawdown of 0.70 foot.

A time-drawdown analyses of the results of the test show an apparent coefficient of transmissibility of about 60,000 gpd., an apparent coefficient of permeability of about 1900 gpd. per sq. ft. and an apparent coefficient of storage of about 0.19.

COMPUTED CONE OF DEPRESSION:

The coefficients of transmissibility and storage obtained from the pumping tests were then used to compute the cone of depression that would be caused by pumping the Ranney well at a constant continuous rate of 2000 gpm for various periods of time, as shown in Figure 4. The computed curves assume no recharge during the period of pumping. It was found that the computed curve for a 180-day period closely approximates the observed drawdown in the Ranney well at an effective radius of 110 feet, the average length of laterals in the collector. This closely approximates equilibrium conditions.

It is our opinion that these curves show the approximate effects to be expected at known distances from the Ranney well under equilibrium conditions in the areas not affected by infiltration from the river, such as the area of the disposal pond where ground water levels are at or near river level. The extent of the cone of depression under the river will undoubtedly be less, because of the infiltration, but since we have no information on the present infiltration rate, we cannot estimate how far upstream under the river the effect of pumping the Ranney well may extend. It is probable that the distance is less than 4000 feet upstream from the Ormet Ranney well.

The computed cone of depression shown in Figure 4 shows that the pumping of the Ormet Ranney well may cause a lowering of ground water levels for a distance of as much as 8000 feet upstream, thereby diverting the flow of ground water toward the Ranney well. The area of the disposal pond and the storage areas of pot liner are within the cone of depression caused by the Ranney well and any seepage or leachate from the disposal pond and the pot liner storage area will be intercepted by the Ranney well.

TEST HOLE 4:

Test Hole 4 is located at the southwest corner of the disposal pond, and both water levels and chemical quality of water show apparent anomalies with respect to the other wells. The test hole is also reasonably close to a low area to the west, through which the flow from a storm sewer carrying waste cooling water from the rectifiers and the gas scrubbers meanders across the low lying land.

The driller reports penetrating 54 feet of brown silty clay above the sand and gravel aquifer which was penetrated from 55 to 87.5 feet.

Water levels in T.H. 4, recorded by automatic water level recorder, have shown greater fluctuations than in any other well for which continuous water level data are available. Water levels have ranged 12.5 feet between elevations 607.9 to 620.4 feet from January 13 to February 9, 1972. Water level changes in the other test holes have been only about one foot or less. The fluctuations of water level have been rapid, the water level rising or falling as much as 5 to 6 feet per day.

When T.H. 4 was pumped for sampling, only a small quantity of water could be pumped before the pump broke suction. Such action suggests that the test hole is partially plugged while the extreme range in water levels suggest the test hole is open.

The water samples obtained from T.H. 4 both by bailer and by pumping by air show low pH (7.0-8.0), low fluoride (4.0-40.0 ppm.) and relatively light color (% of transmittance 6-96), while samples from the 8 inch wells, T.H. 5 and T.H. 9 show a higher content of the contaminate.

PRESENT DISPOSAL POND:

The Ormet plant, as a necessary part of its manufacturing process, is discharging a slurry from the cryolite recovery plant and the pot room gas scrubber system continuously into a disposal pit at an average rate of about 100 gpm. The slurry is a mixture of solids which settle out in the disposal pond and water which leaves the disposal in part by evaporation and we believe in part by underground seepage.

Within the plant area are several disposal ponds used previously that have been filled and are not now in use. These ponds may be as much as 5½ acres in area and have been filled to depths of 10 to 12 feet.

The present disposal pond, which we understand was constructed by raising levees of fill material on three sides is estimated to be about 9 acres in area, although the present water surface is only about 5 acres or less. It is reported that between May 1969, and July 1971, the water surface in the disposal pit was raised about 10 feet to an elevation of 642.4 feet MSL. The water level in the pond is nearly 40 feet higher than ground water levels, suggesting that seepage from the pond is very slow.

The water, which makes up about 80 percent of the slurry being disposed in the pond has a high pH, generally in excess of 10.5 and a high fluoride content ranging from about 900 to 1220 ppm. The water appears to be colored, but the color is not as dark as that pumped from several of the test holes.

It is reported that the amount of slurry going into the pond averages about 100 gpm. We estimate that the slurry is about 20 percent solids, leaving about 80 gpm of water. This is equal to about 115,000 gallons per day or about 42 million gallons per year.

The average annual evaporation rate at Parkersburg, W.Va. is reported as about 34 inches or 0.093 inches per day. If the water surface is 5 acres in extent or about 218,000 square feet, the average evaporation would be:

$$218{,}000 \times \frac{0.093}{12} \times 7.5 \text{ gal./cu.ft.} = 12{,}670 \text{ gallons per day}$$

or about 11 percent of the total water disposed of in the pond. This leaves about 102,330 gallons per day or about 71 gpm to leave the pond by seepage. This is equal to about 37 million gallons per year or about 3.5 percent of the amount of water being pumped from the Ranney well. Coincidentally, the fluoride content of the Ranney well water is about 2 percent of the fluoride content of the disposal pond.

The chemical quality of the effluent being pumped into the disposal pond is not known completely, and a complete chemical analysis is not available at the time of this report. It is known however that the pH of the effluent is normally 10.5 to 11.7 and the fluoride content is 1200 to 1400 ppm.

The effluent is colored, but not as darkly colored as water pumped from several of the test holes. It is reported that the color is due to about 95 percent organic material; that it is in part colloidal; and will settle out on standing, by changing pH and by heating. It has a high causticity and can react with natural earth materials, particularly organic or humic materials. The pH, high fluoride content, and intensity of color are probably closely but not precisely related. The water in the effluent is reported to have the same specific gravity as that of water.

WATER SAMPLES:

Water samples were obtained from all test holes and the 8 inch pumped well by several methods. During the drilling of the test holes, water samples were obtained by bailer. However during the drilling by cable tool methods, it had been necessary to add water (obtained from the sanitary water system supplied by the Omal Ranney well) and there was some question as to the dilation of the ground water by the added sanitary water. Following the completion of the test holes, samples were obtained by air lift method, using a portable air compressor. In several of the holes, the static water level was low and submergence of the airline was not adequate to pump appreciable quantities of water. Because of the apparent variation in chemical quality, the validity of the samples obtained as being fully representative of the water in the aquifer, undiluted by the added sanitary water was questionable.

A small deep well submersible pump and 100 feet of semi-flexible 1-inch plastic pipe was purchased by Ormet and was operated with a portable electric generator provided by Ormet. A set of samples were obtained from all test holes by pumping on February 16-18, 1972, with the exception of T.H. 7. In the drilling of T.H. 7, the lower part of the casing was damaged and it was considered unsafe to try to lower the submersible pump into the well.

All chemical analyses were made in the Ormet plant chemical laboratory and included determinations of pH, fluoride in parts per million, percent transmittace and color.

All chemical analyses and measured water level data for each test hole and well are included in the Appendix and the chemical and water level data for February 16-18, 1972,are shown on Figure 5.

The water obtained from the 8-inch well, T.H. 5, 7,8,9 and 3 all showed 0 percent transmittance and a black color. This appeared to be considerably darker and denser than that of the effluent entering or standing in the disposal pond. During the pumping, particularly of the

8 inch well (which was pumped at a higher rate and for a longer period of time than any of the test holes) a dark brown foam developed. The test holes in which the black color was found are in an elongated area around the disposal pond, south of the pot liner storage area and extending westward to include T.H. 3. Within this area, the water from T.H. 6 and T.H. 4 showed less color and higher percent transmittance.

The highest pH values were found in water from T.H. 6, T.H. 5, the 8 inch pumped well, T.H. 8 and T.H. 3.

The highest fluoride content was found in T.H. 5, T.H. 6, T.H. 8 and T.H. 3, and the 8 inch pumped well.

Water temperatures were measured during the pumping of the water samples and are included on Figure 5. The water temperatures ranged from 51°F in T.H. 6 to 58°F in T.H. 11. The temperature of the Ohio River was probably between 40° and 45°F.

The color, pH, and fluoride content of the water in T.H. 10 and T.H. 11, which are located in the pot liner storage are are low, although the fluoride content at least is somewhat higher than would be expected in the normal ground water.

POSSIBLE SOURCES OF CONTAMINATION:

The area north of the disposal pond where the competitor's pot liner was stored is relatively flat, and it was noticed during the study that pools of water would stand for days at a time without draining away indicating low permeability of the surficial materials. The low pH, fluoride content and color of the water samples from T.H. 10, in the area where the competitor's pot liner had been stored and in T.H. 11 west of the pot liner storage area suggests strongly that the pot liner is not the major source of ground water contamination.

Considering the volumes of water involved, including the water pumped from the Ranney well of about

3 million gallons per day, about 90 million gallons per month, or about 540 million gallons pumped during the past six months since the color appeared in the Ranney well, it is our opinion that the leachate from the pot liner storage area, including both Ormet and the competitor's pot liner is inadequate to be the major source of contamination.

It is our opinion, that the major source of contamination is the disposal ponds, both those previously used and filled and the present disposal pond. It is reported, that the pot room gas scrubber system changed from a calcium system to a sodium system in 1968. At that time three disposal ponds west of the present disposal ponds were used and were filled in February and May, 1969, when use of the present disposal pond was started.

RATE OF GROUND WATER FLOW:

The velocity of ground water flow from the area of the disposal ponds to the Ranney well can be estimated by using an average value for the coefficient of permeability of 2000 gpd. per sq. ft. The coefficient of permeability is defined as the amount of water in gallons per day that will flow through a one-square-foot section of the aquifer under a hydraulic gradient of one foot per foot. A coefficient of permeability of 2000 gpd. per sq. ft. can therefore be converted to a velocity of 267 ft. per day under a hydraulic gradient of one foot per foot.

The actual hydraulic gradient from the disposal ponds area to the collector, based on observed water level elevations on February 16-18, 1972, was plotted in Figure 6. It is shown that the gradient continually changes, being relatively flat in the disposal ponds area and becoming steeper toward the Ranney well. In order to compute the travel time through the full distance, the travel times for 500 intervals of distance were computed, using velocities determined for each interval from the average gradient for the interval. The time required for water to move from the nearest disposal pond about 2100 feet from the Ranney well was computed to be 633 days or about 1.73 years. The time required to travel from the present disposal pond, about 3000 feet, was computed to be 1386 days or about 3.8 years.

Because of the assumptions made, these estimates are only magnitude figures, but we believe that they show that a considerable period of time is necessary to move contaminated water from the disposal pond area to the Ranney well.

The water pumped from the 8 inch pumped well, T.H. 5, T.H. 7, T.H. 8, T.H. 9, and T.H. 3 was black, considerably darker in color than the effluent entering the disposal pond. Although we cannot explain the chemical reactions involved it is our opinion that when the effluent enters the disposal ponds, the solids settle out, decreasing the permeability of the bottoms of the disposal ponds. The seepage or infiltration through the bottom sediments is slow and prolonged contact between the seepage water and the bottom sediments may cause chemical reactions that increase the color of the water seeping from the disposal ponds. The Ormet chemists do not agree with this opinion, but believe the dark color is due to a reaction with organic matter in the ground. Since the surface elevation of the disposal pond is above 640 feet MSL and the ground water level elevations are about 605 feet MSL or less, we believe there is an unsaturated zone in the aquifer below the bottom of the disposal ponds. This is because the seepage rate is controlled by the low permeability of the bottom sediments which is less than that of the aquifer.

The effluent filling the disposal ponds consists of about 20 percent solids which settle out and ultimately fill the disposal ponds. When such filled disposal ponds are not longer in use, the surficial materials dry out, by evaporation of water from the surface and drainage through the underlying fill deposits at a very slow rate. Even though the surficial materials appear dry and solid, it is expected that the bottom several feet may remain semi-liquid for several years and water may continue to drain from the fill materials. It is our opinion that the relatively high contamination in the water from T.H. 3 may be due to the continued draining of contamination from disposal ponds A and B and the third abandoned disposal pond east of pond B.

The results of the present study while perhaps not entirely conclusive from a chemical standpoint have shown, we believe, that the major source of contamination is probably the several disposal ponds which have been and are being filled with effluent from the cryolite recovery plant and the pot room gas scrubber system. It is reported that the pot room gas scrubber system changed from a calcium system to a sodium system in 1968. Rough estimates of the velocity of ground water flow suggest that it may have taken 1.7 to 3.8 years for a particle of water to move from the location of the disposal ponds to the Ranney well. These facts suggest strongly that the contamination of the ground water aquifer is due to the change in the pot room scrubber system from a calcium system to a sodium system, the waste products of which are more soluble, and the slow movement over the period of several years required to move the water from the disposal pond area to the Ranney well.

POSSIBLE MEANS OF CONTROL:

It is our opinion that the continued disposal of the present effluent into the disposal pond constitutes a serious hazard to the present and future water supply of the Ormet and Omal Ranney wells. We are neither chemists nor water treatment specialists and are not in a position to know whether treatment of the effluent before disposal is possible or practical. However, we urge strongly that the possibility of treatment before disposal to remove the high fluoride content and color producing dissolved materials be investigated and considered.

We suggest also that consideration be given to the possibilities of returning to the calcium process formerly used in the pot room scrubber system or to some other system, may be a means of minimizing future pollution problems. The continued disposal of about 70 gpm of water containing excessive quantities of dissolved contaminants that cannot be removed by adsorption or filtration through a sand and gravel aquifer means that such contaminated water must go somewhere. If it is not diverted into your fresh water supply, the only other means of disposal is seepage into the Ohio River.

One of the primary purposes of the present study was to consider the feasibility of preventing the flow of contaminated water from reaching the Ranney well by some type of hydraulic barrier. We believe this to be possible, but it must be realized that such protection of the Ranney well water supply does not completely solve the contamination problem.

Theoretically, the flow of ground water is from areas of higher hydrostatic head, as shown by the water levels in wells to points or areas of lower hydrostatic head. The direction and rate of flow can be changed either by raising the hydrostatic head or water level and diverting the underground flow in a different direction or by lowering the hydrostatic head and intercepting the flow.

A hydraulic barrier can be created by adding water to the aquifer and raising the water level along a linear distance at right angles or across the existing ground water gradient. This can be done through a series of injection wells, the spacing of which and the injection rates being adjusted to create a continuous ridge or cone of impression in the water table to divert the natural flow of water. Such an injection barrier is referred to as a <u>positive barrier</u>.

Similarly, the normal flow of ground water can be intercepted by creating a continuous cone of depression or "trend" in the water table by lowering the water level along a linear distance at right angles to the normal ground water gradient. This can be accomplished by several pumping wells, properly spaced and pumped at proper rates so that the individual cones of depression coalesce and form a continuous lowering of water levels over a considerable distance.

The use of either a positive or negative barrier can be shown to be theoretically possible, but the actual feasibility and the selection of the type of barrier to be used will depend on more accurate determinations of many factors, including: the cost of treating river water for injection, cost of treating the contaminated water pumped for reuse or for proper disposal to the river, actual elevations of present ground water levels along the line of the hydraulic barrier, proper design and costs of wells, interconnecting and other pipelines and power lines and total costs of each type of barrier. Even then, a barrier system may have to be tried on a pilot plant basis and maintained to guarantee its complete success. In either type of barrier, additional monitor wells will be needed to check the success of the barrier.

In order to prevent the flow of contaminated water from the disposal pond area to the Ranney well, a hydraulic barrier either positive or negative must be located in a north-south line west of all disposal pits, probably along the W 4000 range line north and south of T.H. 3. Such a line of wells will be within the plant area and will be reasonably close to existing power lines and to areas of possible reuse of the water pumped.

A well field was assumed consisting of three wells spaced 500 feet apart. The cone of depression or impression was computed using the hydraulic parameters determined by the pumping test for several pumping rates as shown in Figure 5. The total drawdown or build up effects at each of the wells, at the midpoints between wells and at distances of 250 feet north and south of the end wells were computed from Figure 5. Theoretically the buildup or rise in water levels created by injecting a known quantity of water through a well into an aquifer will be the same as the drawdown created by pumping the same quantity of water from the well. With several wells involved, the actual drawdown at any point is equal to the sum of the individual drawdown effects of each pumping well at different distances from the point of observation.

By pumping 200 gpm from each of the three wells continuously or a total of 600 gpm, the water level in the wells could be changed about 9 feet, at the midpoints between wells, about 5.5 feet, and at the end-points 250 feet from the end wells, about 4.4 feet. This means that a trough or buildup in the water table at least 4.4 feet lower or higher than the present water table, can be created over a distance of about 1500 feet. Either type barrier will require the drilling of 3 or more wells to the full depth of the aquifer, each well to be equipped with a commercial well screen 10 to 20 feet long, properly designed, installed and developed, and a permanent deep well turbine pump to be used either for pumping continuously in a negative barrier system or for pumping periodically in a positive barrier system. The latter is necessary to remove any accumulated sediment carried into the well in the recharge water. Either system will require power lines, interconnecting pipe-lines and other pipelines to the source or discharge point of the water.

POSITIVE HYDRAULIC BARRIER:

A major requirement in a positive hydraulic barrier is a source of clean sediment-free water. In our opinion this probably could not be obtained from the Omal Ranney well. The next most obvious source would be water from the Ohio River, which will require extensive treatment, including coagulation, sedimentation, filtration and probably chlorination to be acceptable for injection into the aquifer. Tests should also be made to determine that the mixture of treated river water and contaminated ground water will not cause chemical reactions that result in precipitation of dissolved solids in the aquifer.

The positive or recharge barrier system will add water to the aquifer, which should benefit rather than reduce the capacity of the Ormet Ranney well; will divert the flow of water from the disposal pond area, away from the Ormet Ranney well, so that the flow of water from the disposal area will have to flow elsewhere. Such water will then probably drain underground into the Ohio River at a somewhat higher rate than at present. Increased underground drainage from the contaminated aquifer into the Ohio River may not be permissible.

The more or less continuous injection of river water into the aquifer during the summer months may increase the temperature of the ground water which may or may not be overcome by the injection of cold water during the winter months.

In any positive barrier system, we believe that it will be necessary to pump the wells for short periods of time at relatively high pumping rates to reverse the flow of water through the aquifer surrounding the well in order to remove any accumulated sediment carried into the wells during the recharge cycle. The frequency of pumping or backwashing will have to be determined by actual practice.

NEGATIVE HYDRAULIC BARRIER:

A negative barrier can be created by pumping the proposed wells continuously to cause a lowering of water level along a 1500 foot length perpendicular to the present ground water gradient. The success of a negative barrier will depend, however, on the ability to treat satisfactorily and economically the water being pumped so that it can be reused or disposed of into the Ohio River with an acceptable chemical quality.

The pumping of a negative barrier will intercept the flow of water from the disposal pond area to the Ranney well and will probably decrease the capacity of the Ranney well to a small extent. It may be possible to offset the decrease in the Ranney well by reusing the water pumped to cause the negative barrier. The continuous pumping of the barrier wells will draw water in part from the disposal pond area. If the effluent now being pumped into the disposal pond is treated, continued operation of the negative barrier should ultimately reduce the contamination of the aquifer although this may require many years.

The use of a negative barrier will probably require less supervision and maintenance than a positive barrier.

The costs of a barrier well system are difficult to estimate at this time. In order to properly design the necessary wells, sieve analyses should be run on sand and gravel samples obtained from T.H. 3 and if possible from two additional monitor wells which should be drilled north and south of T.H. 3. This is necessary to determine the type of well that can be constructed at these locations, whether tubular or gravel packed, and to determine the proper length, diameter and screen slot size. We also believe that because of the future rise of normal pool stage to elevation 623 feet MSL (which will be discussed in a later section) the wells should be overdesigned to permit increased pumping rates. In either system, at least several additional monitor wells will be required to check the efficiency of the barrier system and to permit adjustment of the injection or pumping rates. It is our opinion that the cost of a proper hydraulic barrier system could be in the order of magnitude of perhaps $150,000. A complete cost estimate would have to include the costs of pumping, water treatment, maintenance and supervision and cannot be made at this time.

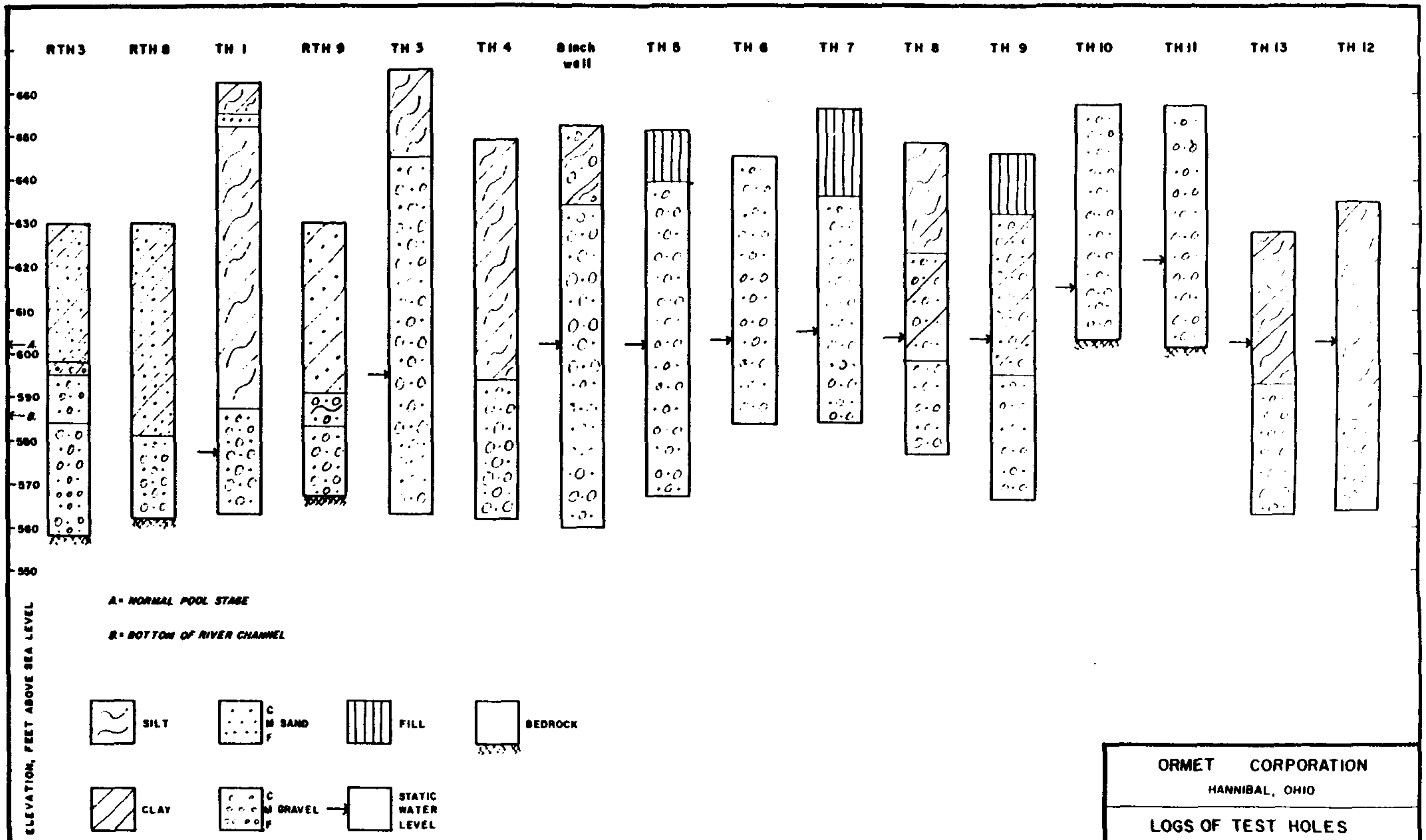
POSSIBLE EFFECTS OF RISE IN NORMAL POOL STAGE OF OHIO RIVER:

The normal pool stage of the Ohio River at the Ormet plant will be raised about 21 feet to elevation 623 feet MSL by the closing of the Hannibal Locks and Dam about three miles downstream. The dam is now under construction and is scheduled for completion late in 1973. The rise in water level will mean that the same quantity of water will flow through a larger cross-sectional area and therefore the velocity of flow will be smaller. The construction of the dam is such that water will be released under the dam by tainter gates which will be raised or lowered to control the river stage. Whether this will create a current along the river bottom that may be effective in minimizing temporary silting is not known.

The rise in river stage will probably raise the water level in the disposal pond area about 21 feet to elevations of about 623 to 627 feet MSL. Since the bottoms of the disposal ponds are probably not lower than elevation 632 feet MSL, a few feet of the aquifer should remain unsaturated and the bottoms of the disposal ponds should not be in contact with the water table in the aquifer. Therefore we believe that the rise in pool stage will not result in an increase in contamination to the aquifer.

In the vicinity of the Ranney well, we believe that the ground water levels are below river levels within a radius of 2000 to 3000 feet due to a restricted infiltration rate through the river bottom. Theoretically the infiltration rate should be directly proportional to the head of water above the river bottom and an increase in head of 21 feet should double the present infiltration rate. This, however, may be offset by increased silting of the river bottom. It is our opinion that the rise in river level will cause a rise in static and pumping levels in the Ranney wells shortly after the Hannibal Dam is closed, but as the river bottom becomes silted, static and pumping levels may decline over a period of time.

Assuming that water levels in the disposal pond area are raised 21 feet and at the Ranney well are raised somewhat less, the ground water gradient to the Ranney well may be increased and it may be necessary to increase the injection rate or pumping rate to or from the hydraulic barrier to compensate for such a rise. Therefore in designing wells for the hydraulic barrier system, the well screens and possibly the permanent pumps should be overdesigned to permit the pumping or injection of perhaps as much as 600 gpm per well.



ORMET CORPORATION
HANNIBAL, OHIO

LOGS OF TEST HOLES

FRED H. KLAER JR & ASSOCIATES

Figure 2

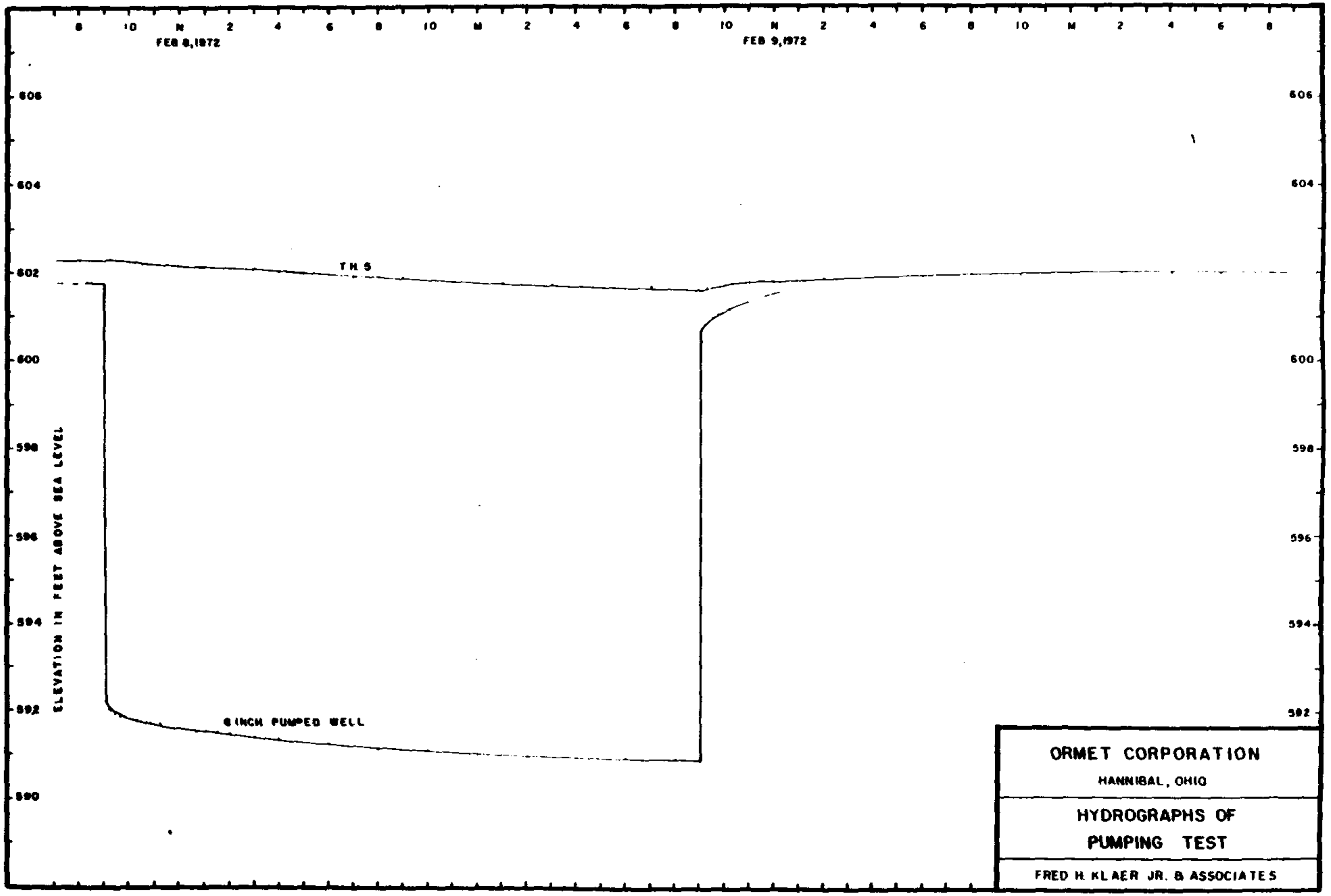
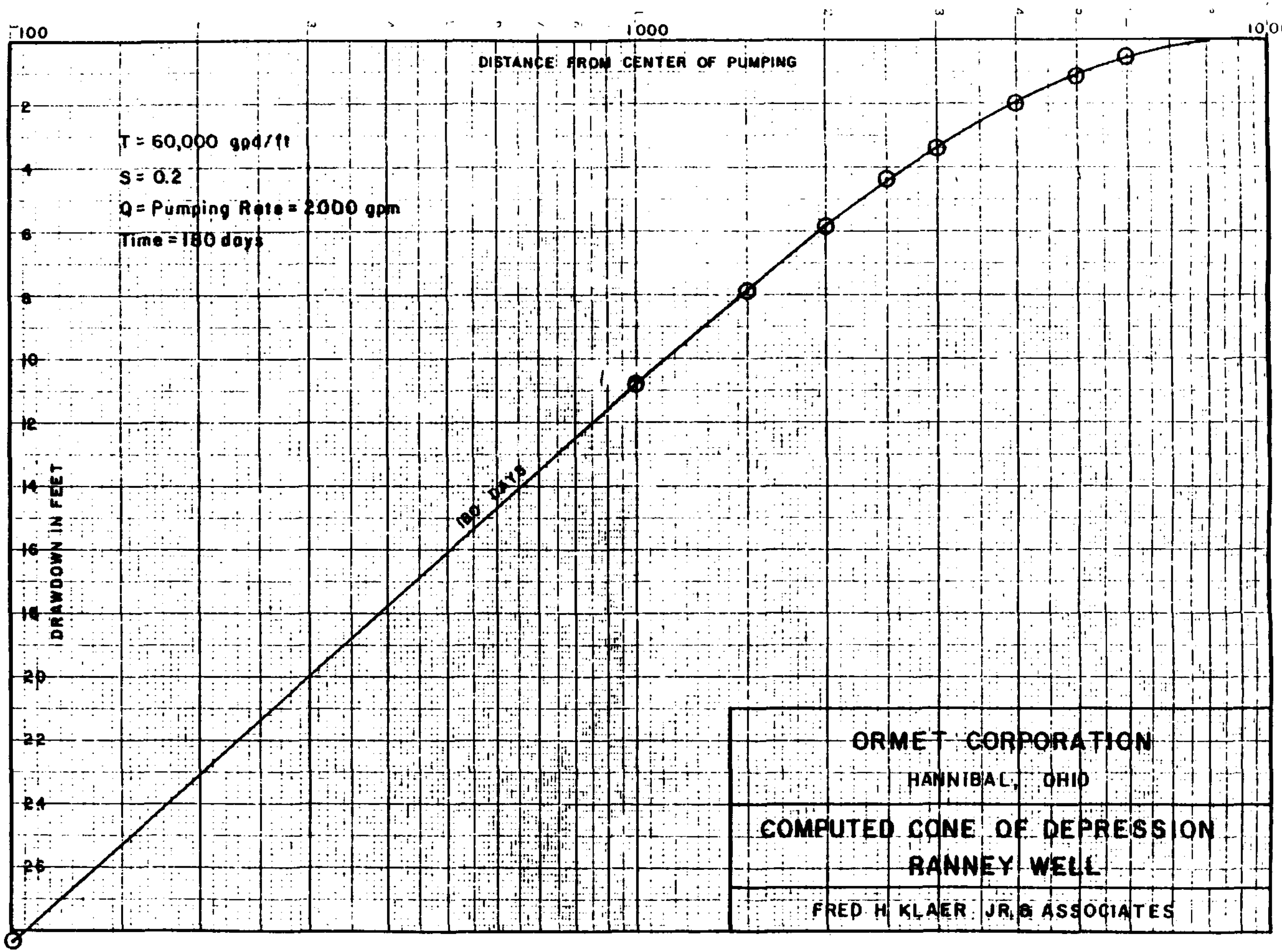

8 10 N 2 4 6 8 10 M 2 4 6 8 10 N 2 4 6 8 10 M 2 4 6 8
FEB 8,1972
FEB 9,1972
606
604
602
600
598
596
594
592
590
ELEVATION IN FEET ABOVE SEA LEVEL
T.H. 5
8 INCH PUMPED WELL
ORMET CORPORATION
HANNIBAL, OHIO
HYDROGRAPHS OF
PUMPING TEST
FRED H. KLAER JR. & ASSOCIATES

Figure 3



100
1000
10000
DISTANCE FROM CENTER OF PUMPING
DRAWDOWN IN FEET
2
4
6
8
10
12
14
16
18
20
22
24
26
T = 60,000 gpd/ft
S = 0.2
Q = Pumping Rate = 2000 gpm
Time = 180 days
180 DAYS
ORMET CORPORATION
HANNIBAL, OHIO
COMPUTED CONE OF DEPRESSION
RANNEY WELL
FRED H. KLAER JR. & ASSOCIATES

Figure 4

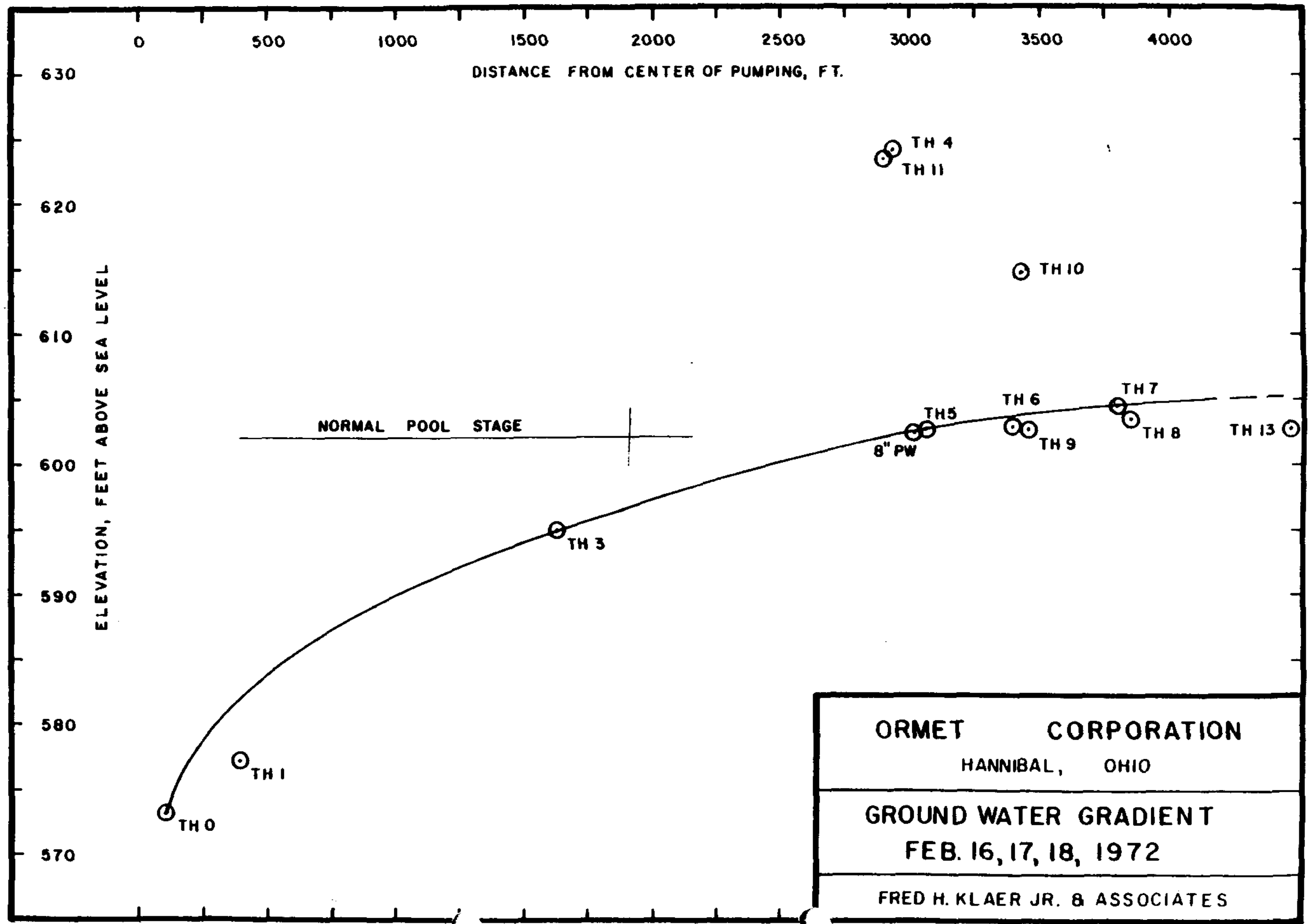
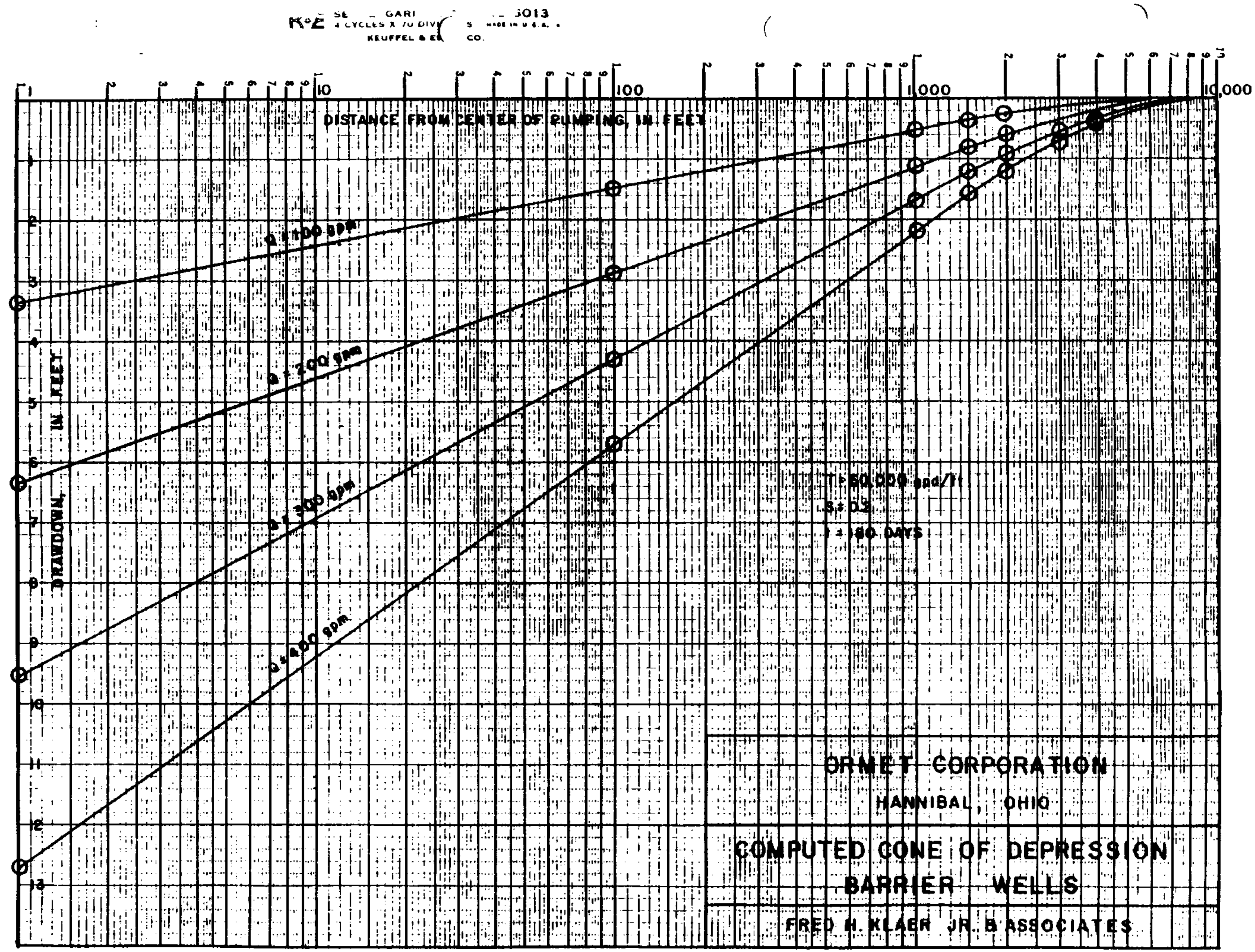

0
500
1000
1500
2000
2500
3000
3500
4000
DISTANCE FROM CENTER OF PUMPING, FT.
630
620
610
600
590
580
570
ELEVATION, FEET ABOVE SEA LEVEL
TH 4
TH 11
TH 10
NORMAL POOL STAGE
TH 7
TH 6
TH5
TH 8
TH 9
8" PW
TH 13
TH 3
TH 1
TH 0
ORMET CORPORATION
HANNIBAL, OHIO
GROUND WATER GRADIENT
FEB. 16, 17, 18, 1972
FRED H. KLAER JR. & ASSOCIATES

Figure 6



DISTANCE FROM CENTER OF PUMPING, IN FEET
DRAWDOWN, IN FEET
Q = 100 gpm
Q = 200 gpm
Q = 300 gpm
Q = 400 gpm
T = 50,000 gpd/ft
S = 0.2
t = 180 DAYS
ORMET CORPORATION
HANNIBAL, OHIO
COMPUTED CONE OF DEPRESSION
BARRIER WELLS
FRED H. KLAER JR. & ASSOCIATES

Figure 7

APPENDIX

ELEVATIONS

WATER LEVEL AND CHEMICAL ANALYSES

TEST BORINGS

		ELEV.	LOCATION		
STA #	1	664.00	TOP OF CASING		
"	2				
"	3	667.49	"	"	"
"	4	651.76	"	"	"
"	5	653.74	"	"	"
"	6	646.36	"	"	"
"	7	653.19	"	"	"
"	8	649.57	"	"	"
"	9	648.40	"	"	"
"	10	658.17	"	"	"
"	11	658.75	"	"	"
"	12	638.55	"	"	"
"	13	631.30	"	"	"
PUMP HOLE		654.62	TOP OF STAKE		
Pump Well		654.25	Top of casing		

DVE 1-21-72
REV 2-16-72

PHASE 2

HYDROGEOLOGICAL SURVEY OF

PLANT WATER SUPPLY - 1972

ORMET CORPORATION

For

THE ORMET CORPORATION
ALUMINUM REDUCTION DIVISION
HANNIBAL, OHIO

By

FRED H. KLAER, JR. AND ASSOCIATES
CONSULTING GEOLOGISTS AND HYDROLOGISTS
COLUMBUS, OHIO

September 27, 1972

TABLE OF CONTENTS

INTRODUCTION:

A detailed hydrogeological survey of the Ormet plant water supply was made during December 1971 to February 1972, to determine insofar as possible the sources of contamination of the Ranney well water, to trace the direction and rate of movement of such contamination and to suggest means of minimizing or controlling the contamination. The study included the installation of 12 test holes or monitor wells and the collection and analyses of water samples by pumping. All chemical analyses were made by Ormet personnel. The results of the study were presented in a report entitled, Hydrogeological Survey of Plant Water Supply-1972, dated March 1, 1972. The general conclusions reached were that the major source of contamination to the ground water reservoir was the disposal pond from which about 70 gpm of contaminated water was seeping continuously; that the Ormet Ranney well after 15 years of pumping had established a cone of depression from valley wall to valley wall, which extended eastward to the disposal pond area; that the cause of contamination was due to a change in the pot room gas scrubber system in 1968 from a calcium to a sodium system; and that it required about 1.7 to 3.8 years for the contamination to travel from the several disposal ponds (some now abandoned) to reach the Ranney well. The report also suggested that the contaminated water could be diverted from the Ranney well by a positive or negative barrier well system.

After a review of the results and conclusions of the report, it was decided that additional work was required. Phase 2 of the hydrogeological survey included the drilling of five additional monitor wells between the Ormet and the Omal Ranney wells to prove that the contaminated water had not migrated west of the Ormet well and that the Ormet well was serving as an effective negative barrier to prevent the movement downstream of the contaminated water. Two additional wells were drilled on the southwest edge of the pot liner storage area to determine whether the leachate from the pot liner material due to rainfall contributed to the contamination of the ground water supply. A new pumping rig to obtain representative samples of water for chemical analyses was designed and constructed for the Ormet Corporation. Two rounds of water samples about one month apart were obtained from 16 of the available monitor wells and several additional rounds of water level measurements were made. Records of precipitation and river stage were studied for possible correlation with changes in chemical quality.

Phase 2 was authorized by Ormet Purchase Order No. OH-073894, dated June 5, 1972.

The work performed and the information obtained during Phase 2 of the study are discussed in detail in the following Report. However, in order to facilitate a review of the basic results of the work, the Summary of Conclusions and Recommendations are reported here.

SUMMARY AND CONCLUSIONS:

1. The drilling and water sampling of T.H.-15, 16, 17, 18 and 19 showed that the water obtained from all monitor wells in the vicinity of the Ormet Ranney well including T.H.-0 and T.H.-1, was not contaminated. Based on this evidence, it is our opinion that the Ormet Ranney well is intercepting all underground flow of contaminated water downstream or west of the Ormet well toward the Omal Ranney well about 2100 feet downstream.

2. The drilling and water sampling of T.H.-14A showed the presence of considerable quantities of ammonia in the water when the well was pumped. Ormet chemists state that ammonia can be derived only from the pot liner material and not from the waste water in the disposal pond. This is specific evidence that the leachate from the pot liner storage area contributes at least in part to the contamination of the ground water.

3. The disposal pond, however, is still believed to be the major source of contamination because of the presence of high chlorides and decreasing fluorides in the monitor wells and the continuous disposal of about 100,000 gallons of water per day seeping into the ground water reservoir.

4. The water from all available monitor wells within 1500 feet of the Ormet Ranney well show no evidence of contamination while the water from the Ranney well is high in pH, and fluorides and low in transmittance. We recommend that a detailed pumping and sampling test of the Ormet Ranney well be made to determine which laterals are contributing contaminated water. Since the Ranney well cannot be taken out of service, the determination will have to be based on chemical changes that occurr when individual laterals are closed. If the contamination is limited to one or two laterals, additional monitor wells may be needed to determine the width of the zone and the concentrations of contaminated water.

5. The addition of hydrochloric acid to the disposal pond has increased the chlorides and reduced the fluorides in the pond water. Although analyses of chloride of the water from the monitor wells prior to the addition of the acid are not available, it is our opinion that similar increases in chloride and decreases in fluoride have been shown in the monitor wells surrounding the disposal pond. No significant changes have been noticed in T.H.-3 or the Ranney well water.

6. The chemical quality of water in the disposal pond changes with reductions of pH and with periods of rainfall. The changes in the Ranney well water are believed to be due mainly to periods of higher river stage.

7. Depending on the results of the recommended Ranney well test, several additional monitor wells may be needed to determine the extent of the contaminated water zone between T.H.-1 and T.H.-3.

8. It is our opinion that the results obtained during Phase 2 of the hydrogeological survey basically confirm the general conclusions of Phase 1, except for the fact that the leaching by rainfall of the pot

liner material does contribute to the contamination problem at least to some extent. The other conclusions of Phase 1 remain essentially the same.

Respectfully submitted,

FRED H. KLAER, JR. & ASSOCIATES
Consulting Ground-Water Geologists
and Hydrologists

by Fred H. Klaer Jr.
Fred H. Klaer, Jr.
Certified Professional Geologist No.75
Registered Geologist (California)
No.1798

FHKJr:eh

REPORT

TEST DRILLING:

In the first phase of the study it was concluded that the pumping of the Ormet Ranney well had developed a cone of depression that extended to both the north and south walls of the bedrock valley and therefore would be completely effective in intercepting any contaminated water moving downstream from the pot liner storage and disposal pond area. However in order to be forewarned of any possible contamination from the disposal pond area, five 6-inch diameter monitor wells were drilled in a T-shaped pattern between the Ormet and the Omal Ranney wells. Three wells, T-15, T-16 and T-19 were drilled along the top of the river bank and were spaced about 500 feet apart. T-17 and T-18 were drilled along a line north of T-16, and along the west fence of the Ormet property, at spacings of about 500 feet. No water-bearing material was found in T-18 above the bedrock, which was found at elevation 578 feet above mean sea level and the test well was filled and abandoned. The locations of the test holes are shown in Figure 1 and their well logs are shown in Figure 2.

The test holes were drilled by cable tool methods using standard 6-inch ID pipe and each well was equipped with a five foot section of commercial well screen, having a slot opening of 0.040 inch. Each well was developed by bailing to remove the fine material from the aquifer surrounding the well screen.

Two additional monitor wells were drilled in the pot liner storage area to determine the possible effects of leaching of the pot liner material by rainfall. T.H.-14 was drilled at a location, about 410 feet southeast of T.H.-11 and about 330 feet south of T.H.-10. Sand and gravel was found between depths of 30 and 46 feet, but was dry and contained no water. The test hole was continued to bedrock at a depth of 55 feet, at an approximate elevation of 600 feet above mean sea level. T.H.-14A was drilled about 130 feet south of T.H.-14, and was about 350 feet west of T.H.-6 and 210 feet north of T.H.-5. Water-bearing sand and gravel was found between depths of 29 and 37 feet, and from 45 to 65 feet. Bedrock was struck at 69 feet or at approximate elevation ~580 feet above mean sea level. The locations of these test holes are shown in Figure 1 and the logs are shown in Figure 2.

The addition of these test holes increases the total number of test holes included in the two phases of the study to 19, of which 16 are considered suitable as monitor wells. T.H.-14 and 18 yielded no water. T.H.-7 has a break in the well casing which prevents the use of a pump for water sampling and T.H.-4 shows striking anomalies in water level and chemical quality so that its value as a representative monitor well is questionable. T.H.-0, near the Ormet Ranney well, is also included as a monitor well. During the present study, several days were spent in pumping and redeveloping all the existing monitor wells except Well 7 with varying degrees of success. T.H.-4, T.H.-10, and T.H.-11 can be pumped dry within short periods of time. The remaining wells appear to be open and are able to sustain pumping at rates up to 15 gpm for at least one hour.

We recommend that all future monitor wells be drilled by a competent well driller by cable tool methods and be equipped with a commercial well screen which should be properly developed at the time of installation.

PUMPING EQUIPMENT:

As a part of the study, a new pumping outfit was designed and constructed. This includes a modified Peerless Dynaflow 4-inch diameter submersible pump, 3/4 horsepower, Model 4D75B-10-2, 230 volt single phase. The pump is a semi-positive displacement pump with a helical rotor rotating in a seamless rubber stator and is capable of pumping reasonable quantities of sand. The check valve has been removed from the top of the pump to permit backflow of water through the stator to flush it clean. The pump is attached to 115 feet of 1-inch ID semi-flexible plastic pipe. The three wire power cable of the pump is brought up inside the plastic pipe, in order to protect the electrical cable and to facilitate handling.

The upper end of the plastic pipe is permanently attached to a 5-foot diameter reel, which will hold the 115 feet of plastic pipe in a single lay. The water pumped passes through a connection on the reel to the 2-inch pipe axle and is ejected from one end of the axle. The power cable is carried through a water-tight stuffing box and is taken out the opposite end of the axle. The reel is hung vertically in a portable stand and the two can be separated for hand carrying.

The pump is powered by a Kohler Model 3MM65, 3000 watt, 120/240 volt, 7 horsepower generator set, which is equipped with the necessary control box, fuses and knife switch. During operation, the generator, control box and reel are all grounded to the well casing.

In practice, the pumping rig is used from the back of a pickup or flat-bed truck, which is backed up to the well to be pumped. The pump and plastic pipe are unreeled directly down the well. The reel is equipped with a handrail to facilitate the operation of the reel. It is possible with this rig to be pumping within ten minutes after reaching the well.

WATER SAMPLING:

On July 25 and 26, 1972, and on August 29 and 30, 1972, a round of water samples was collected by pumping from each test hole or monitor well using the new pump rig. Each well was pumped for approximately one hour where possible. T.H.-0, T.H.-4, T.H.-10 and T.H.-11 were pumped for shorter periods of time because of the inability of the test wells to support steady pumping. The pumping rate was generally 12 to 15 gpm.

The results of chemical analyses of these samples are presented in Table I and are shown on Figure 1. In Table I the results of a similar round of water samples obtained, by pumping, in February 1972, are included for comparison. Analyses were made by personnel in the Ormet chemical laboratory.

TABLE I

CHEMICAL QUALITY OF WATER FROM MONITOR WELLS

Test Hole	February, 1972 Water Elev.	pH	Fluor. ppm.	% Trans.	Temp. °F	July, 1972 Water Elev.	pH	Fluor. ppm.	% Trans.	Cl. ppm	Temp. °F.
0	573.60	7.9	1.6	92	55	584.47	8.0	1.0	96	62	58
1	577.66	7.9	1.0	98	57	589.74	7.9	1.3	77	29	56
3	594.41	10.1	468	0	57	601.26	10.2	325	0	443	59
4	621.35	7.0	9	74	54	611.43	7.1	15	29	132	59
5	602.23	10.5	980	0	59	606.69	10.4	340	0	2792	59
PW8"	601.97	10.2	550	0	57	605.35	10.7	585	74	4100	59
6	603.73	11.1	950	58	51	605.60	9.8	100	17	1817	68
7	605.13	9.8	250	0	-	606.07	-	-	-	-	-
8	603.54	10.4	770	0	54	607.44	10.3	520	0	647	57
9	602.87	9.9	430	0	54	603.83	9.3	133	2	355	58
10	614.93	7.9	10	98	-	614.71	7.9	7	2	-	59
11	621.75	7.1	6	0	58	621.64	7.7	8	60	142	57
12	602.43	6.9	0.82	97	58	602.19	6.9	0.25	80	19	60
13	602.90	7.1	0.74	98	55	603.18	6.7	0.15	73	79	56
14A	-	-	-	-	-	605.45	10.5	1260	0	122	69
15	-	-	-	-	-	588.21	8.1	1.0	87	21	63
16	-	-	-	-	-	586.82	8.2	1.0	98	27	59
17	-	-	-	-	-	587.71	7.4	0.16	93	39	58
19	-	-	-	-	-	586.51	8.0	1.3	96	29	56
River	-	-	-	-	-	602.6	-	-	-	-	73

TABLE I
(CONTINUED)
CHEMICAL QUALITY OF WATER FROM MONITOR WELLS

August 29-30, 1972

Test Hole	Water Elev.	pH	Fluor. ppm.	% Trans.	Chloride ppm.	Temp. °F.
0	579.76	8.0	1.3	100	27	-
1	583.72	8.1	1.5	90	27	55
3	597.40	10.1	440	80*	425	59
4	609.90	6.7	11	59	355	59
5	606.51	10.3	350	96*	2446	59
PW8"	602.60	10.2	280	94*	3528	59
6	604.25	7.9	30	68	1241	75
7	604.65	-	-	-	-	-
8	602.97	10.4	700	93*	1135	58
9	602.68	9.3	180	94*	833	59
10	614.44	7.2	2.5	97	128	59
11	621.45	7.8	4.5	65	117	60
12	-	-	-	-	-	-
13	-	-	-	-	-	-
14A	603.58	10.1	550	80*	1897	-
15	581.92	7.9	1.0	99	32	64
16	581.62	8.2	1.3	98	27	59
17	581.47	7.3	0.9	99	34	58
19	580.88	8.0	1.5	99	28	58
River	602.6	-	-	-	-	82
River	603.6	-	-	-	-	83

* 1-10 Dilution

RIVER STAGE AND PRECIPITATION DURING, 1972:

Data on river stage and precipitation at Dam 15, have been obtained from the Ohio River Summary and Forecasts, published daily except on weekends. During January and February, the river stage fluctuated generally between elevations 599.5 and 606 feet MSL. On February 26, the river rose reaching stages of 618.2 feet MSL on March 4 and again peaked on March 19 at elevation 621.3 feet MSL. In April, the river reached a stage of 614 feet MSL on April 18. During May and early June the river was more or less at or below normal pool stage of 602.2 feet MSL.

On June 23, the river rose rapidly, peaking at elevation 630.6 feet MSL. The river returned to pool stage by July 22, 1972. A hydrograph of the river and daily precipitation is shown in Figure 3. The water levels in the monitor wells on June 30 were 13 to 16 feet higher than on February 18, 1972.

The precipitation at Dam 15 by months for 1972 to date has been as follows:

Month	Inches	Month	Inches
January	3.24	May	3.27
February	3.56	June	7.82
March	3.15	July	3.86
April	5.19	August	3.27

It should be noted that the water samples of February 1972, were obtained following two months of more or less normal rainfall. The water samples of July were obtained following a month of high river stage and heavy rainfall, and ground water levels in July were considerably higher than in February,1972. The water samples of August were obtained after a period of about 30 days during which the river remained at pool stage and rainfall was about normal.

FACTORS THAT MAY AFFECT THE CHEMICAL QUALITY OF WATER IN MONITOR WELLS:

In addition to precipitation and changes in river stage, several other factors should be mentioned that may or may not affect the chemical quality of the ground water.

On January 28, 1972, one hundred and fifteen tons of calcium chloride were dumped into the disposal pond, which undoubtedly increased the chloride content of the disposal pond water.

In order to reduce the pH and the fluoride content and to increase the transmittance of the disposal pond water, hydrochloric acid was added to the disposal pond, starting on March 4, 1972. From March 4 to August 30, about 80 truck-loads or about 1800 tons of acid were added to the disposal pond. Prior to the addition of the acid, the disposal pond water had a pH of 10 to 11 and a fluoride content of 900 to 1200 ppm. The continued addition of acid has reduced the pH to 6.6 to 9.0 and the fluoride content now ranges from about 70 to 300 ppm.

The reduction in the fluoride content in the disposal pond water has not caused any significant reduction in the fluoride content of the Ranney well water.

CHANGES IN CHEMICAL QUALITY OF WATER FROM THE MONITOR WELLS:

The changes in chemical quality in the water pumped from the monitor wells are shown in detail in Table I and on the summary sheets for each individual well are included in the Appendix. The known changes in fluoride content in six monitor wells in the dispoal pond area and in T.H.-3 are plotted in Figure 4. All the monitor wells in the disposal pond area have shown major changes in fluoride content, while the fluoride content of the water from T.H.-3 has shown no significant change.

Analyses of chloride content were made for the samples collected in July and August 1972. Since no analyses of chloride prior to July 1972 are available, the normal chloride contents of the water in the disposal pond or of the normal ground water are not known. Based on the chloride contents in T.H.-0, 1,12,13,15-19 which are at a considerable distance from the disposal pond, it is our opinion that the normal chloride content of the ground water is less than 100 ppm. It is interesting to note that the original analysis of water pumped at Site D, the location of the Ormet collector, showed 60 ppm chloride on May 29,1956, compared to 62 ppm chloride in T.H.-0 on July 25, 1972.

Between July 25 and August 29, 1972, the chloride content increased in T.H.-4, T.H.-8, T.H.-9 and T.H.-14A and decreased in PW-8", T.H.-3, T.H.-5, T.H.-6 and T.H.-11. During August, the amount of acid added to the disposal pond was slightly less than that added during July.

The maximum chloride contents shown in PW-8", T.H.-5, T.H.-6 and T.H.-8, all situated close to the disposal pond, show that high chlorides are leaking from the disposal pond, probably at points between PW-8" and T.H.-6 and possibly near T.H.-8. **The high chloride content in T.H.-3 is surprising and at the moment we can offer no valid explanation.**

T.H.-14A is located on the "downstream" side of the potliner storage area and would intercept water draining in a southwesterly direction under the stored pot liner material. In pumping T.H.-14A for sampling, a strong odor of ammonia was noticed. This, according to the Ormet chemists, is derived from the pot liner material.

In considering the continued use of hydrochloric acid to reduce the pH and fluoride content of the water in the disposal pond, it must be remembered that such use of acid is already causing high chloride content in several of the monitor wells, which can be expected to increase further. Conceivably it may increase to the point where ultimately the chloride content of the Ranney well water may increase beyond tolerable levels.

High chlorides have been used successfully as tracers of ground water flow in many studies. Chlorides are completely soluble and can travel long distances underground without precipitation.

All samples of water from the monitor wells, especially T.H.-3, and periodically samples of water from the disposal pond and the Ormet Ranney well should be analyzed for chloride content. Such analyses should show by the change in chloride content the rate and direction of the flow of contaminated water from the disposal pond toward the Ranney well.

POSSIBLE CONTAMINATION OF THE OMAL RANNEY WELL:

The drilling of T.H.-15, 16, 17, 18, and 19 during June and July 1972, was primarily to determine the possible movement of contaminated water past the Ormet Ranney well to the Omal Ranney well about 2100 feet downstream. A theoretical contour map of the water table under the combined Ormet-Omal properties is shown in Figure 5. The generalized contours represent lines of equal elevation of the water table and the flow lines indicating the direction of ground water flow cross each contour line at right angles. Water flows from higher elevations of the water table to lower elevations of the water table. The contour interval is approximately 5 feet.

The pumping from the Omal Ranney well is reported to be about 3000 gpm or about 15 to 35 percent greater than the pumpage from the Ormet Ranney well. Therefore the cone of depression of the Omal well is somewhat larger than that of the Ormet well and the highest elevation of the water table between the two wells is probably between T.H.-15 and T.H.-16.

Since the major part of the water pumped from both wells is derived from infiltration from the river, the contour lines are spaced more closely on the river side than the land side, indicating steeper ground-water gradients.

Along the north side of the terrace, the aquifer pinches out, but receives some drainage from the higher ground to the north. Here the water table contours are closely spaced because of low permeability of the residual soils.

The chemical analyses of water sampled from all test holes in the vicinity of the Ormet Ranney well on July 25 and August 30, 1972 showed pH values of 7.3 to 8.2, fluoride contents of 0.15 to 1.5 ppm and transmittances of 97 to 99 percent. During the same period, the water from the Ormet Ranney well showed pH values of 9.4 to 9.5, fluoride contents of 24 to 27 ppm and transmittances of 34 to 42 percent. The chemical quality of the water sampled from the test holes appears to be normal for the natural uncontaminated ground water in this area.

It is our opinion based on this evidence that the pumping of the Ormet Ranney well has created a cone of depression that has completely intercepted the flow of contaminated water toward the Omal Ranney well and that no contaminated water has passed underground downstream from the Ormet Ranney well.

It is our opinion that if pumping from the Ormet Ranney well is stopped, the continued pumping of the Omal well will ultimately extend its cone of depression far enough to the northeast to intercept some contaminated water from the disposal pond area, although the amount of water to be intercepted may be somewhat less than that intercepted by the Ormet well.

THE EFFECT OF STORED POT LINER MATERIAL ON THE CHEMICAL QUALITY OF GROUND WATER:

The pot liner storage area lies generally in the area between T.H.-10, 11 and 14 and just north of T.H. 14-A. The depth to bedrock in T.H.-14 is about 20 feet higher than in T.H. 14-A and the main sand and gravel aquifer underlying the terrace may pinch out between the two test holes. The generalized water table contour map shows that water entering the terrace deposits along the north edge of the terrace will flow generally southward under the pot liner storage area. This will also be true of rainfall falling on the weathered pot liner material, which will leach out soluble chemical compounds in the pot liner material.

During the test pumping of T.H. 14-A, a strong odor of ammonia developed, which according to the Ormet chemists is definitely leached from the pot liner material. This is evidence that leachate from the stored pot liner material does contribute to the contamination of the ground water. While it is a contributing factor, it is still our opinion that the major source of contamination is the disposal pond. The actual quantity of leachate, derived from intermittent rainfall is too small, compared to a continuous seepage loss of about 70 gpm from the disposal pond, to account for the heavy contamination in the monitor wells in the disposal pond area.

A study of the chloride contents of samples from the various monitor wells shows that the highest concentration is from PW-8", T.H.-5, T.H. 14-A, T.H.-6 and T.H.-8, showing lesser concentrations further away from the disposal pond. The apparent decreases in fluoride content from February to July and August 1972, following the decrease in fluoride content of the disposal pond water proves that the seepage of water from the disposal pond adversely affects the chemical quality of the ground water.

ORMET RANNEY WELL:

It is our understanding that in July and August 1971, it was noticed that the water pumped from the Ormet Ranney well was discolored and contained high fluorides. Since December 1, 1971, the fluoride content of the Ranney well water has ranged from about 6 to 37 ppm. Samples of water pumped from T.H.-0 about 70 feet from the Ranney well and within the lateral pattern and from T.H.-1, 380 feet east and slightly north of the Ranney well have shown fluoride contents of 1.0 to 1.8 ppm and 1.0 to 2 ppm respectively. Transmittances have ranged between 80 and 100 percent and 34 and 98 percent respectively, while transmittances of the Ranney well water have ranged from about 17 to 66 percent. The contamination of the Ranney well water is consistently greater than that from the two test wells.

During the fall of 1971, an attempt was made by Ormet to determine which laterals were contributing contaminated water to the Ranney well and it appeared that most if not all the contamination was coming from laterals 6 and 7, extending 128 feet northwest and 117 feet north from the Ranney well. It is our opinion that a similar test should be repeated in the immediate future, while the Ohio River is still essentially in pool stage. We recommend that the following procedure be followed:

1. Careful records should be kept of pumping levels and pumping rates prior to and during the testing.

2. Samples of water should be obtained at hourly intervals prior to the start of the test and should be analyzed for pH, fluoride and transmittance.

3. One lateral at a time should be closed for a period of 2 to 6 hours starting with lateral 7. The length of time the lateral is closed will depend on what changes occur in the water pumped. Samples should be obtained and analyzed at 1 to 2 hour intervals as in 2. above.

4. All eight laterals should be closed one at a time and tested following the procedure outlined above.

5. A period of normal pumping with all laterals open of 2 to 6 hours should follow the opening of a closed lateral, to permit the reestablishment of normal conditions between changes of laterals.

6. The recommended test will require perhaps 8 hours per lateral or about 3 days, testing on a 24 hour per day basis.

It is our opinion that the proposed test on the Ranney well described above is essential in order to determine where the contamination is entering the well. It is important to test all eight laterals separately to eliminate the possibility that contamination is entering the Ranney well from the river side. The test should be run under carefully controlled conditions, following the same procedure for each lateral, so that the results of the test will be comparable.

In the event that the proposed Ranney well test shows that the contamination is entering through one or two laterals, several additional monitor wells may be required to define the width of the zone contributing the contamination to the well. If it can be shown that all contamination is entering the Ranney well in a narrow zone, it may be possible to reduce significantly the contamination to the Ranney well by installing one or two vertical wells to create a negative barrier fairly close to the Ranney well. The practicability of such a plan must await the results of the testing recommended above.

GENERAL CONCLUSIONS:

The test drilling and water sampling program included in Phase 2 of the hydrogeological survey in our opinion confirm rather than contradict our original conclusions reached during the first phase. The drilling of and water sampling from T.H.-15, 16, 17, 18, and 19 prove conclusively that the Ormet Ranney well has intercepted completely the underground flow of contaminated water from the disposal pond area toward the Omal Ranney well.

The drilling and water sampling of T.H.-14 and T.H.-14A and the presence of ammonia in T.H.-14A, which the Ormet chemists insist can be derived only from the leaching of the pot liner material and not from the disposal pond, are direct evidence that leaching of the pot liner material is responsible at least in part for the contamination of the ground water.

However, the evidence of high chlorides in the water from all the monitor wells surrounding the disposal pond show that water from the disposal pond is reaching the ground water reservoir. According to the Ormet chemists, the pot liner material contains no chloride. Considering the quantities of water that are seeping from the disposal pond, which we estimate as about 24 million gallons during the first 8 months of 1972, compared to the quantities of leachate from the pot liner storage caused by about 33 inches of rainfall, which we estimate as less than 2 million gallons during the same period, it is still our opinion that the disposal pond is the major source of the contamination.

A major question that so far remains unaswered is how and where does the contaminated water reach the Ormet Ranney well? All water samples obtained from monitor wells within 1500 feet of the Ranney well show chemical qualities which we believe are normal for the ground water and show no contamination, while water from the Ranney well is persistently contaminated. Since the available monitor wells are east and west of the Ranney well, the contamination must reach the Ranney well from the north or south. Additional information on this problem will be obtained by the Ranney well test previously recommended.

The reduction of pH in the disposal pond by the addition of hydrochloric acid has reduced the fluoride content of the pond water and also of the ground water obtained from the monitor wells surrounding the pond. No significant changes in fluoride content have been noticed in either T.H.-3 or the Ranney well, after five months of pH reduction in the pond water. A study of the changes in chemical quality of the pond water and the Ranney well water suggest that the major changes in the disposal pond water are caused by the reduction of pH by the adding of acid and by rainfall, while the major changes in the Ranney well water are caused by changes in river stage. During higher stages of the river, infiltration rates increase because of the higher head and a greater proportion of river water is infiltrated to the Ranney well.

The water sampled from T.H.-3 is definitely contaminated and from T.H.-1 about 1400 feet west is not contaminated. Relative elevations of water levels and theoretical considerations indicate that water is flowing from T.H.-3 to T.H.-1 and to the Ranney well. How far the front of contaminated water has moved west of T.H.-3 is not known. It is our opinion that for Ormet's protection one or two additional monitor wells should be drilled between T.H.-1 and T.H.-3. The actual location of such holes should not be decided until after the Ranney well test is run.

In our previous report, we have suggested controlling the movement of contaminated water from the disposal pond by means of a positive or negative hydraulic barrier, the most practical location for which will be along the north-south road at the east end of the plant, between the old loading docks and the east end of the parking area.

The relative merits and difficulties of both positive and negative barrier systems have already been discussed in our previous report. The major disadvantage of a negative hydraulic barrier will be the necessity to treat the water that is pumped. The major disadvantage of the positive hydraulic barrier will be to provide a source of sediment-free water for recharge through wells. If river water is used, extensive treatment of the water to remove the suspended solids may be required. It might be possible to obtain sufficient water for recharge from new vertical wells to be located between the two Ranney wells or downstream from the Omal Ranney well.

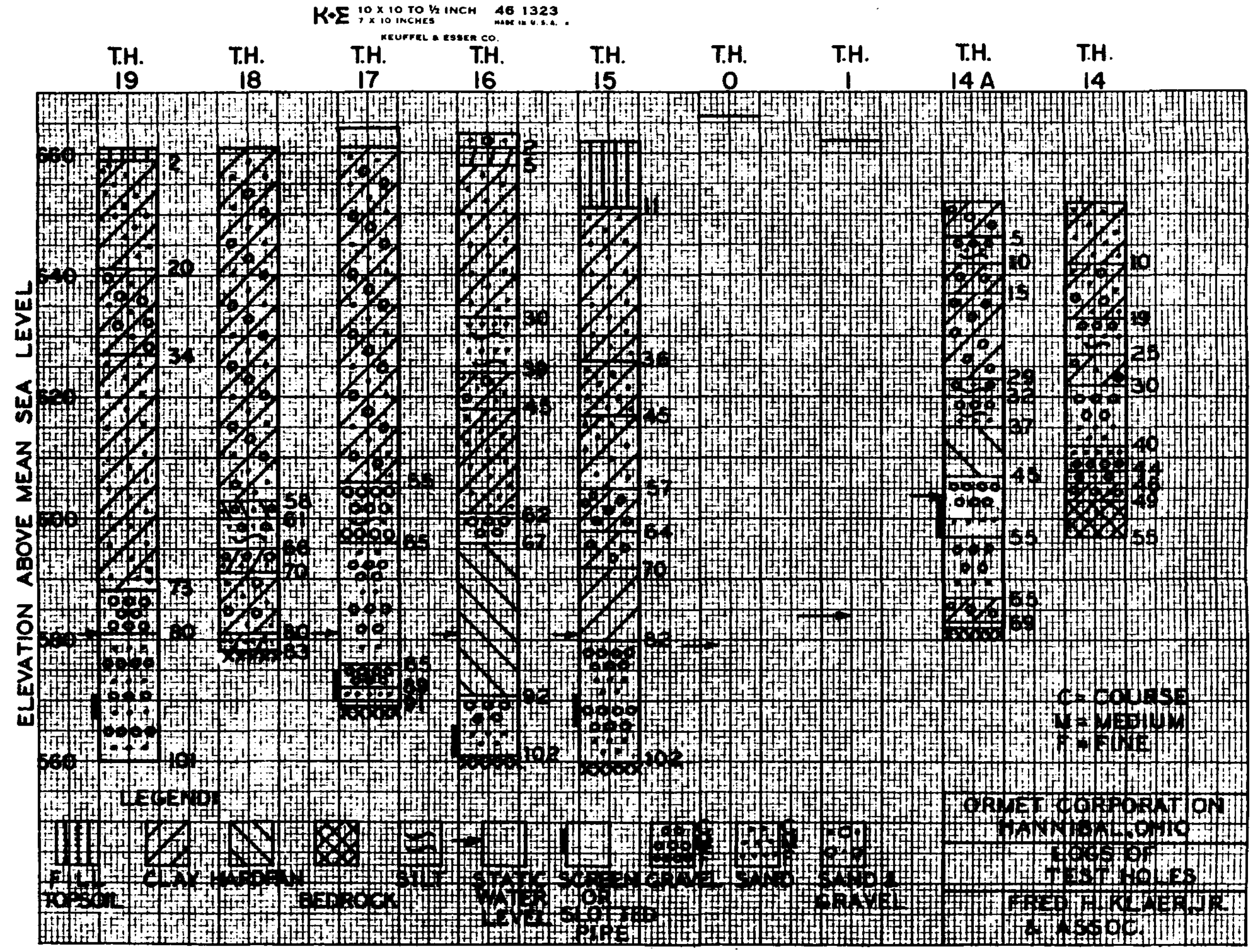

K•E 10 X 10 TO ½ INCH 46 1323
7 X 10 INCHES MADE IN U.S.A.
KEUFFEL & ESSER CO.
T.H. 19
T.H. 18
T.H. 17
T.H. 16
T.H. 15
T.H. 0
T.H. 1
T.H. 14 A
T.H. 14
ELEVATION ABOVE MEAN SEA LEVEL
660
640
620
600
580
560
LEGEND:
TOPSOIL
CLAY
HARDPAN
BEDROCK
SILT
STATIC WATER LEVEL
SCREEN OR SLOTTED PIPE
GRAVEL
SAND
SAND & GRAVEL
C = COURSE
M = MEDIUM
F = FINE
ORMET CORPORATION
HANNIBAL, OHIO
LOGS OF TEST HOLES
FRED H. KLAER JR. & ASSOC.

FIGURE 3

FRED H. KLAER, JR. & ASSOCIATES
CONSULTING GROUND-WATER GEOLOGISTS AND HYDROLOGISTS
16 LELAND AVENUE COLUMBUS, OHIO 43214
P.O. BOX 3496
PHONE 888-6633

September 26, 1972

The Ormet Corporation
P.O. Box 176
Hannibal, Ohio 43931

File
cc: CDL (3)
WTB
HLR
JMB
BSP

Attention: Mr. Bernard Paidock

Gentlemen,

We are enclosing eight copies of our report entitled, "Phase 2, Hydrogeological Survey of Plant Water Supply-1972, Ormet Corporation", dated September 27,1972. If you should need additional copies, please let us know.

The work described in this report was authorized by Ormet Purchase Order No. OH-073894, dated June 6, 1972, in the lump sum amount of $15,000, in accordance with our amended proposal of June 1, 1972. It is our opinion that we have completed the work covered by this Purchase Order and that we can now submit an invoice for the balance due of the specified amount of the Purchase Order.

We appreciate having the opportunity of making this study for you and we hope to be of service to you again in the future.

Very truly yours,

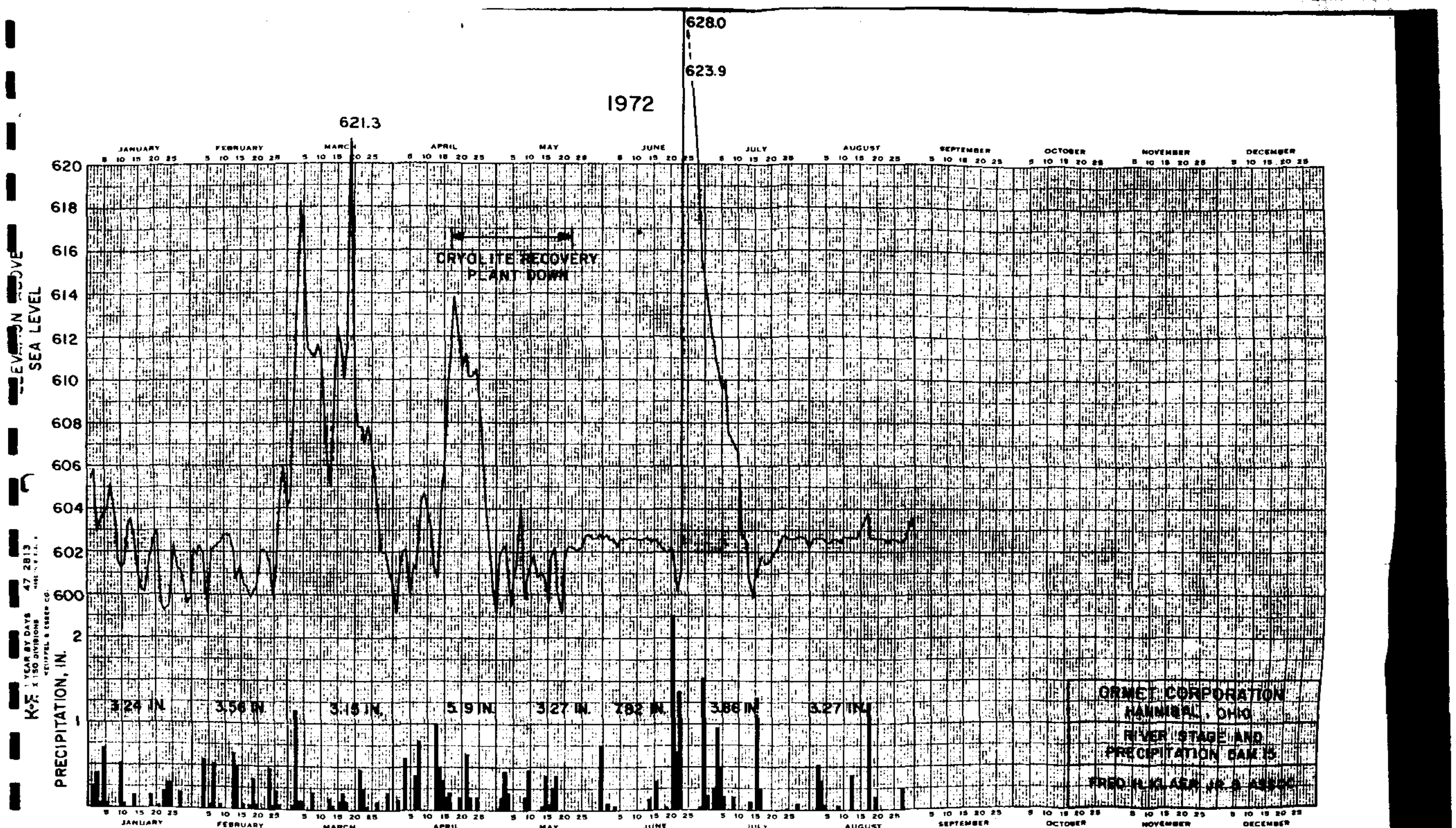
FRED H. KLAER, JR. & ASSOCIATES

Fred H. Klaer Jr.

Fred H. Klaer, Jr.
Consulting Ground-Water Geologists
and Hydrologists

FHKJr:eh

Encl.



1972
621.3
628.0
623.9
ELEVATION ABOVE SEA LEVEL
PRECIPITATION, IN.
CRYOLITE RECOVERY PLANT DOWN
3.24 IN.
3.56 IN.
3.15 IN.
5.9 IN.
3.27 IN.
7.82 IN.
3.86 IN.
3.27 IN.
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
ORMET CORPORATION
HANNIBAL, OHIO
RIVER STAGE AND
PRECIPITATION DAM 15

FIGURE 3

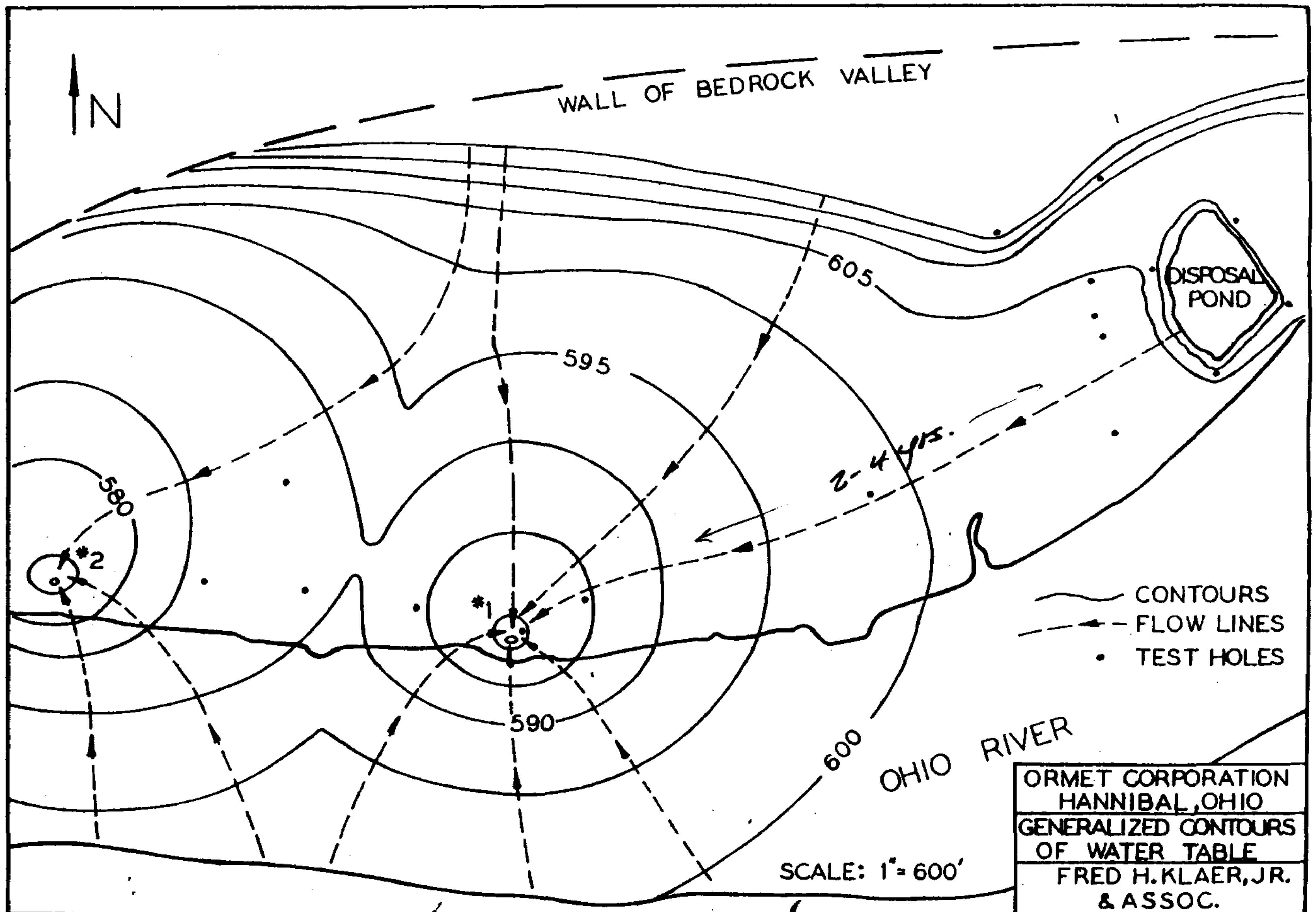

N
WALL OF BEDROCK VALLEY
605
DISPOSAL POND
595
580
*2
*1
2-4 yrs.
590
600
OHIO RIVER
CONTOURS
FLOW LINES
TEST HOLES
SCALE: 1" = 600'
ORMET CORPORATION
HANNIBAL, OHIO
GENERALIZED CONTOURS OF WATER TABLE
FRED H. KLAER, JR. & ASSOC.

FIGURE 5

FRED H. KLAER, JR. & ASSOCIATES
COLUMBUS, OHIO

PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO (Near Ranney Well)

Well TH-O **Date Drilled** ________ **Depth** ________

Diameter 6" **Casing Length** ________

Screen Length ________ ~~Setting~~ Sounded 99'

Measuring Point Top of casing ±.5' above Land Surface

Elevation - Top of casing 666.00

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	Temp		Elev.
2-18-72	0800			92.40		SL	573.60
2-18-72	0900			92.86		PL	573.14
6-30-72	2:55p	80	-0.80	79.20			586.80
7-11-72	2:05p	75.0	+1.04	76.04			589.96
7-19-72	0945	80	.46	79.54			586.46
7-25-72	1020	80	+1.53	81.53	63°F	SL	584.47
½ hr	1125	95	-0.75	94.75	58°F	PL	571.25
8-25-72	1045	85	+1.70	86.70			579.30
8-29-72	1900	85	+1.24	86.24			579.76
9-13-72	1120	80	+2.38	82.38			583.62

CHEMICAL ANALYSIS

Date	~~Time~~ Depth	~~Hold~~ pH	~~Cut~~ Fppm	~~Depth~~ % TRANS	Color	Sample	Cl ppm
2-18-72	30 Min	7.9	1.8	94	Clear	Pp	
	60 Min	7.9	1.6	92	"	Pp	
7-30-72	10 Min	7.5	1.1	80			
	30 Min	8.0	1.0	96			62
8-29-72	4 MIN	7.8	1.4	99			
	30 MIN	8.0	1.3	100			27

CHEMICAL ANALYSIS

Date	DEPTH Time	PH ~~Hold~~	F ppm ~~Cut~~	% TRANS. ~~Depth~~	COLOR	SAMPLE	Cl ppm
1-11-72	80	6.8	1.3	98		B	
1-11-72	85	7.6	1.6	63		B	
1-12-72	90	7.7	1.6	68		B	
1-12-72	99	7.6	1.5	96		B	
1-19-72	5 Min	7.5	13.0	98		Pa	
1-19-72	30 Min	7.9	2.3	98		Pa	
1-19-72	1 hr	8.1	1.9	98		Pa	
1-20-72	5 Min	7.9	3.3	91		Pa	
1-20-72	25 Min	7.9	3.8	92		Pa	
2-17-72	30 Min	8.1	2.	98		Pp	
2-17-72	60 Min	8.1	1.	98		Pp	
2-17-72	2 hrs	7.9	1.	98		Pp	
7-19-72	15 Min	7.8	1.6	34	TAN	P	
7-19-72	60 Min	7.9	1.3	77	TAN	P	
7-19-72	95 Min	7.9	1.3	90	TAN	P	29
8-29-72	15 MIN	8.1	1.4	69%			
	60 MIN	8.1	1.5	98			

FRED H. KLAER, JR. & ASSOCIATES
COLUMBUS, OHIO

PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well TH-1 **Date Drilled** JAN. 72 **Depth** 101'

Diameter 6" **Casing Length** 101'

Screen Length — Sounded ~~Setting~~ 96.1'

Measuring Point Top of casing 1.8' above land Surface

Elevation - Top of Casing 664.00

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	Temp.		Elev.
1-19-72	1400	85	-	85.00			579.00
1-20-72	1750			83.50			580.50
1-27-72	0647	85	-.98	84.02			579.98
2-08-72	0715	86	-.07	84.93			579.07
2-08-72	1415	85	.00	85.00			579.00
2-09-72	0745	85	.00	85.00			579.00
2-17-72	2330			86.34		SL	577.66
2-18-72	1:30p			86.80		PL	577.20
6-30-72	2:06p	75	-2.29	72.71			591.29
7-11-72	2:10p	70	+1.10	71.10			592.90
7-19-72	0752	75	-0.74	74.26		SL	589.74
7-19-72	0930	75	-0.51	74.49	56°	PL	589.51
7-26-72	1120	78	+1.13	76.13			587.87
8-25-72	1055	80	+0.78	80.78			583.22

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COLUMBUS, OHIO

PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well Th-1 **Date Drilled** JAN. 72 **Depth** 101'

Diameter 6" **Casing Length** 101'

Screen Length – ~~Setting~~ Sounded 96.1'

Measuring Point TOP OF CASING 1.8' ABOVE LAND SURFACE – ELEVATION-TOP OF CASING 664.00

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	TEMP		ELEV
8-29-72	14.30	80	+0.28	80.28	56°		583.72
8-29-72	1530	80	+0.50	80.50	55°		583.50
9-13-72	1130	80	-1.77	78.23			585.77

Date	Time	Hold	Cut	Depth			

FRED H. KLAER, JR. & ASSOCIATES
COLUMBUS, OHIO

PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well TH-3 **Date Drilled** Dec. 1971 **Depth** 104.5'

Diameter 6" **Casing Length** 104.5'

Screen Length - ~~**Setting**~~ Sounded 91.1'

Measuring Point Top of Casing 2.5' above Land Surface

Elevation - Top of Casing 667.49'

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	Temp.		Elev.
1-6-72	1545	70	+.72	70.72			596.77
1-13-72	1710	70	+.87	70.87			596.62
1-20-72	1600	70	+1.30	71.30			596.19
1-27-72	0655	70	+1.24	71.24			596.29
2-08-72	0721	70	+2.25	72.25			595.24
2-08-72	1420	70	+2.27	72.27			595.22
2-09-72	0750	70	+2.22	72.22			595.27
2-17-72	1825			73.08			594.41
	1915			73.87			593.62
6-30-72	1400	60	-0.51	59.49			608.00
7-11-72	2:32p	65	-2.21	62.79			604.70
7-18-72	1803	65	+1.23	66.23		SL	601.26
7-18-72	1910	65	+1.95	66.95	59°	PL	600.54
7-26-72	1125	65	+2.60	67.60			599.89
8-25-72	1100	70	+0.57	70.57			596.92

CHEMICAL ANALYSIS

Date	~~Time~~ DEPTH Time	~~Hold~~ PH	~~Cut~~ ppm	~~Depth~~ % TRANS.	COLOR	SAMPLE	Cl ppm.
12-30-71	80	8.0	4.	97		B	
12-30-71	87	9.2	175	0		B	
1-3-72	87	9.3	150	0		B	
1-19-72	5 Min.	9.9	340	0		Pa	
1-19-72	30 Min.	9.8	320	0		Pa	
1-19-72	1 hr.	9.8	310	0		Pa	
1-20-72	5 min	9.8	320	0		Pa	
1-20-72	30 Min	9.8	320	0		Pa	
2-17-72	30 Min	10.1	468	0	Black	Pp.	
	60 Min	10.1	468	0	Black	Pp.	
4-3-72	5 hrs 2:00 P	10.3	410	0			
4-27-72	1:30 P	10.05	310	89 ✓	Dark		
5-17-72	12 N	10.2	340	88 ✓			
6-22-72	4 hrs	10.1	370	89 ✓	Black		
7-18-72	15 Min	10.2	325	0	Black	P	443
7-18-72	60 Min	10.2	325	0	Black	P	
8-24-72	60 MIN	10.1	440		BLACK		390
8-30-72	15 MIN	10.1	440	86 ✓			
	60 MIN	10.1	440	87 ✓			425

Page 1 See Above ✓ = 1/100 Dilution

FRED H. KLAER, JR. & ASSOCIATES
COLUMBUS, OHIO

PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well Th-3 Date Drilled DEC. 1971 Depth 104.5'

Diameter 6" Casing Length 104.5'

Screen Length — ~~Setting~~ SOUNDED 91.1'

Measuring Point Top of Casing 2.5' Abov Land

SURFACE ELEV. TOP OF CASING 667.49

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	TEMP.		ELEV
8-30-72	0805	70	+0.09	70.09	59°		597.40
8-30-72	1025	70	+0.86	70.86	59°		596.63
9-13-72	1135	70	-0.06	69.94			597.55

Date	Time	Hold	Cut	Depth			

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COLUMBUS, OHIO

PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well TH-4 **Date Drilled** Jan. 1972 **Depth** 89.5'

Diameter 6" **Casing Length** 89.5'

Screen Length — ~~Setting~~ Sounded 84.6'

Measuring Point Top of Casing +2.5' above Land Surface

Elevation - Top of Casing 651.76'

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	Temp.		Elev.
1-13-72	1500	45	1.47	43.53			608.23
1-19-72	1745	45	1.13	43.87			607.89
1-20-72	0830	45	1.14	43.86			607.90
1-27-72	0745	40	1.30	38.70			613.06
2-17-72	0505			34.40			617.36
2-17-72	1615			30.41	54°		621.35
6-30-72	1345	30	-2.32	27.68			624.08
7-11-72	3:05	35	-0.98	34.02			617.74
7-25-72	1540	40	+.33	40.33	59°		611.43
	Can break section - dry hole						
7-26-72	1857	40	+2.25	42.25			609.51
8-25-72	1235	40	+0.90	40.90			610.85
8-30-72	1300	40	+1.86	41.86	59°		609.90
9-13-72	1212	35	+0.60	35.60			616.16

CHEMICAL ANALYSIS

Date	DEPTH Time	~~Hold~~ PH	~~Cut~~ Fppm	% TRANS ~~Depth~~	COLOR	SAMPLE	Cl ppm.
1-7-72	25	7.0	4.0	89		B	
1-11-72	35	8.1	9.5	6		B	
1-11-72	50	7.8	9.3	5		B	
1-12-72	65	7.5	10.1	64		B	
1-12-72	75	7.7	14.0	77		B	
1-12-72	80	8.0	35.0	57		B	
1-12-72	85	8.0	40.0	59		B	
1-13-72	2 Min	7.6	9.0	82		Pa	
1-13-72	30 Min	7.6	12.0	96		Pa	
1-13-72	1 hr.	8.0	31.0	59		Pa	
1-20-72	5 Min	7.7	8.8	86		Pa	
1-20-72	30 Min	7.7	8.3	77		Pa	
2-17-72	10 Min	6.9	8	72	Yellowish	Pp	
2-17-72	30 Min	7.0	9	74	Yellowish	Pp	
7-25-72	1	7.0	10	53			
	5	6.7	10	21			
	15	7.0	10	31			
	60	7.1	15	29			132
8-30-72	5	6.7	11	82			
	30	6.7	11	59			355

FRED H. KLAER, JR. & ASSOCIATES
COLUMBUS, OHIO

PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well TH-5 **Date Drilled** Jan. 1972 **Depth** 86.0

Diameter 6" **Casing Length** 86.0

Screen Length — ~~Setting~~ Sounded 67.9

Measuring Point Top of casing 2.5' above land surface

Elevation - Top of casing 653.74

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	Temp.		Elev.
1-18-72	1110	50	+.70	50.70			603.04
1-19-72	1740	50	+.15	50.15			603.59
1-20-72	0700	50	+.22	50.22			603.52
		50	+.32	50.32			603.38
2-16-72	1530.			51.51	57°F	SL	602.23
	1630			53.21	59° F	PL	600.53
6-30-72	1332	40	-1.64	38.36		SL	615.38
7-11-72	2:50p	45	-1.78	43.22			610.52
7-19-72	1610	45	+2.05	47.05		SL	606.69
7-19-72	1715	50	+.96	50.96	59°F	PL	602.78
7-26-72	1350	50	-.80	49.20			604.54
8-25-72	1145	50	+0.92	50.92			602.82
8-30-72	1045	45	+2.23	47.23	59°		606.51
8-30-72	1145	55	-1.63	53.37	59°		600.85

CHEMICAL ANALYSIS

Date	Depth Time	~~Hold~~ PH	~~Cut~~ F ppm	~~Depth~~ % TRANS	Color	Sample	Cl ppm
1-13-72	45	9.8	380	0		B	
1-13-72	50	9.8	540	0		B	
1-13-72	55	10.1	500	0		B	
1-14-72	65	10.0	700	0		B	
1-14-72	70	10.5	600	0		B	
1-14-72	75	10.5	620	0		B	
1-14-72	80	10.4	665	0		B	
1-14-72	84	10.4	665	0		B	
1-18-72	30 m	10.2	830	0		Pa	
1-18-72	30 min	10.2	850	0		Pa	
1-18-72	1 hr.	10.3	890	0		Pa	
1-20-72	5 min	10.4	880	0		Pa	
1-20-72	30 min	10.3	920	0		Pa	
2-16-72	30 min	10.5	1000	0	Black	P	
	60 min	10.5	980	0	Black	P	
7-19-72	15 Min	10.3	420	0	Black	P	
	60 min	10.4	340	0	Black	P	2792
8-30-72	15 MIN	10.3	460	96+ ✓			
	60 MIN	10.3	350	96 ✓			

✓ SEE ABOVE = 1/100 DILUTION

FRED H. KLAER, JR. & ASSOCIATES
COLUMBUS, OHIO

PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well TW.5 Date Drilled JAN. 72 Depth 86.0'

Diameter 6" Casing Length 86.0'

Screen Length — Sounded Setting 67.9'

Measuring Point Top of Casing 2.5' Above Land Surface

Elevation Top of Casing 653.74

MEASUREMENTS:

Date	Time	Hold	Cut	Depth			
9-13-72	1205	50	-1.11	48.89			604.85

Date	Time	Hold	Cut	Depth			

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PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well TH-6 **Date Drilled** Jan. 1972 **Depth** 63'

Diameter 6" **Casing Length** 63'

Screen Length ______ Sounded ~~Setting~~ 57.15'

Measuring Point Top of casing 1.5' above land surface

Elev. - Top of casing 646.36

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	Temp		Elev.
1-6-72	1410	40	+.34	40.34			606.02
1-13-72	1115	40	+.35	40.35			606.01
1-20-72	1100	40	+1.98	41.98			604.38
1-27-72	0717	40	+1.78	41.78			604.58
2-16-72	1355	40	+2.63	42.63	51°F	SL	603.73
2-16-72	1510	40	+3.40	43.40	51°F	PL	602.96
6-30-72	1308	30	-0.96	29.04			617.32
7-11-72	3:00p	35	-0.06	34.94			611.42
7-25-72	1445	40	+.76	40.76	68°F	57.2 SL	605.60
7-25-72	1550	40	+1.27	41.27	68°F	PL	605.09
8-25-72	1530	40	+2.20	42.20			604.16
8-30-72	1323	40	+2.11	42.11	75°	SL	604.25
8-30-72	1420	40	+2.69	42.69	75°	PL	603.67
9-13-72	1235	40	+2.28	42.28			604.05

CHEMICAL ANALYSIS

Date	Depth Time	~~Hold~~ pH	~~Cut~~ F ppm	% IPAINS ~~Depth~~	Color	Sample	Cl ppm
1-4-72	55	11.2	920	0		B	
1-11-72	5 Min	10.9	1030	15		Pa	
	20 Min	11.0	1030	40		Pa	
	1 hr	11.0	1030	68		Pa	
	2 hr	11.0	1050	60		Pa	
1-20-72	5 Min	11.0	985	30		Pa	
1-20-72	30 Min	11.0	925	28		Pa	
2-16-72	30 Min	11.1	1000	57	Dark Tea	P	
	60 Min	11.1	950	58	Dark Tea	P	
4-28-72	2:00P	11.0	140	94			
7-25-72	15 Min	9.9	100	14			
	60 Min	9.8	100	17			1817
8-30-72	15 MIN	8.1	30.4	64			
	60 MIN	7.9	30	68			1241

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PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well TH-7 **Date Drilled** Jan. 1972 **Depth** 73.8

Diameter 6" **Casing Length** 73.8

Screen Length - ~~Setting~~ Sounded 59.3' *

Measuring Point Top of casing 1.8' above land surface

Elev- Top of casing 658.19

* casing broken

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	Temp.		Elev.
1-13-72		50	+1.59	51.59			606.60
1-20-72	1255	55	1.94	53.06			605.13
1-27-72	0800	50	+2.80	52.80			605.39
6-30-72	1570	40	-0.29	39.71			618.48
7-11-72	3:30p	45	+1.14	46.14			612.05
7-25-72	1405	50	+2.12	52.12			606.07
8-25-72	1305	55	-1.34	53.66			604.53
8-30-72	1347	55	-1.46	53.54			604.65
9-13-72	1226	55	-1.25	53.75			604.44

CHEMICAL ANALYSIS

Date	Depth ~~Time~~	pH ~~Hold~~	~~Cut~~ Fppm	% TONS. ~~Depth~~	Color	Sample	Cl ppm
1-11-72	72'	10.0	364	0		B	
1-19-72	5 Min	9.8	250	0		Pa	

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PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well TH-8 **Date Drilled** Jan. 1972 **Depth** 73.75'

Diameter 6" **Casing Length** 73.75'

Screen Length — ~~Setting~~ Sounded 73.7'

Measuring Point Top of casing +1.9' above land surface

Elevation - Top of casing 649.57

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	Temp.		Elev.
1-13-72	1055	45	1.97	43.03			606.54
1-19-72	1800	45	+.87	45.87			603.70
1-20-72	1015	45	+.69	45.69			603.88
1-27-72	0757	45	.15	44.85			604.72
2-8-72	0802	45	+1.34	46.34			603.23
2-8-72	1127	45	+1.32	46.32			603.25
2-8-72	1532	45	+1.31	46.31			603.26
2-9-72	0822	45	1.42	46.42			603.15
2-16-72	1220	45	+1.03	46.03	54°F	SL	603.54
2-16-72	1330	45	+1.65	46.65	54°F	PL	602.92
6-30-72	1315	30	-0.19	29.81			619.76
7-11-72	3:25	40	-1.58	38.42			611.15
7-25-72	1335	40	+2.13	42.13	57°F	SL	607.44
	1435	45	+1.54	46.54	57°F	PL	603.03
8-25-72	1300	45	+1.84	46.84			602.73

CHEMICAL ANALYSIS

Date	Depth Time	~~Hold~~ PH	~~Cut~~ Ppm	~~Depth~~ % Trans.	Color	Sample	Cl ppm.
1-3-72	60	7.1	3	84		B	
1-3-72	65	9.0	160	0		B	
1-4-72	67	9.7	320	0		B	
1-4-72	70	9.9	360	0		B	
1-13-72	30 sec	8.	7.7	68		Pa	
1-13-72	5 Min	9.9	330	0		Pa	
1-13-72	30 Min	10.1	390	0		Pa	
1-13-72	3 hrs	10.4	550	0		Pa	
1-13-72	3½ hrs	10.4	520	0		Pa	
1-20-72	5 Min	10.5	600	0		Pa	
1-20-72	30 Min	10.4	540	0		Pa	
2-16-72	30 Min	10.4	770	0	Black	P	
	60 Min	10.4	720	0	Black	P	
4-27-72	11:15a	9.5	180	965	Dark		
7-25-72	15 Min	9.9	375	0			
	60 Min	10.3	520	0			647
8-30-72	15 Min	10.3	680	94 ✓		P	
	60 Min	10.4	700	93 ✓		P	1135

DATE	TIME	Hold	CUT	DEPTH	TEMP		ELEV
8-30-72	1425	45	+1.60	46.60	59°		602.97
8-30-72	1525	45	+2.72	47.72	58°		601.85
9-13-72	1222	45	+1.50	46.50			603.07

✓ Dilution 1/100

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PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well TH-9 **Date Drilled** Jan. 1972 **Depth** 82.0'

Diameter 6" **Casing Length** 82.0'

Screen Length — ~~**Setting**~~ Sounded 73.5'

Measuring Point Top of casing 2.2' above land surface

Elev. Top of casing 648.40

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	Temp		Elev.
1-13-72	1342	40.0	+2.45	42.45			605.95
1-19-72	1750	45	.00	45.00			603.40
1-20-72	0950	45	.25	44.75			603.65
1-27-72	0755	45	.94	44.06			604.34
2-16-72	1010	45	+.53	45.53	54°F	SL	602.87
2-16-72	1200	45	+.70	45.70		PL	602.70
6-30-72	1324	30	+1.38	31.38			617.02
7-11-72	3:15p	40	+0.21	40.21			608.19
7-19-72	1945	45	.43	44.57			603.83
7-25-72	1225	45	-0.43	44.57	58½°	SL	603.83
	1325	45	-.11	44.89	58½°	PL	603.51
8-25-72	1250	45	+0.90	45.90			602.50
		SEE	NEXT	COLUMN			

CHEMICAL ANALYSIS

Date	~~Depth~~ Time	~~Hold~~ PH	~~Cut~~ F ppm	~~Depth~~ % Trans.	Color	Sample	Cl ppm
1-5-72	61	9.8	340	0		B	
1-6-72	78	8.1	63	41		B	
1-13-72	30 sec.	7.5	27	96		Pa	
1-13-72	30 min	9.1	125	0		Pa	
1-13-72	1 hr	9.2	142	0		Pa	
1-20-72	5 Min	10.2	520	0		Pa	
1-20-72	30 Min	10.0	350	0		Pa	
2-16-72	30 Min	9.9	380	0	Black	P	
	60 Min	9.9	430	0	Black	P	
7-25-72	15 Min	8.6	85	4		P	
7-25-72	60 Min	9.3	133	2		P	355
8-30-72	15 MIN	9.2	150	97			
	60 MIN	9.3	180	94			833

DATE	TIME	Hold	CUT	DEPTH	TEMP		ELEV.
8-30-72	1440	45	+0.72	45.72	59°		602.68
	1630	45	+1.07	46.07	59°		602.33
9-13-72	1216	45	+.53	45.53			602.87

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PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well TH-10 **Date Drilled** Jan. 1972 **Depth** 56.7'

Diameter 6" **Casing Length** 56.7'

Screen Length ______ Sounded ~~Setting~~ 50.9'

Measuring Point Top of Casing 1.7' above land surface

Elev - Top of casing 658.17

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	Temp.		Elev.
1-19-72	1500	45	0.51	44.49			613.68
1-20-72	1515	45	1.58	43.42			614.75
1-27-72	0805	45	1.69	43.31			614.86
2-8-72	0807	45	1.68	43.32			614.85
2-8-72	1134	45	1.63	43.37			614.80
2-8-72	1540	45	1.64	43.36			614.81
2-9-72	0830	45	1.58	43.42			614.75
2-18-72	1200	45	1.76	43.24			614.93
6-30-72	1303	40	+0.18	40.18			617.99
7-11-72	3:35p	40	+2.55	42.55			615.62
7-25-72	1555	45	1.54	43.46	49.3°	SL	614.71
8-25-72	12:42	40	-0.78	39.22			618.95
8-30-72	1340	45	-1.27	43.73	59°		614.44
9-13-72	1230	45	-1.27	43.73			614.44

*Broke suction

CHEMICAL ANALYSIS

Date	Depth Time	~~Hold~~ PH	~~Cut~~ F ppm	% TRANS. ~~Depth~~	Color	Sample	Cl ppm
1-11-72	20	9.5	260	0	(Soaked Sample)		
1-19-72	5 Min	7.6	1.1	98		Pa	
1-19-72	30 Min	7.8	.85	98		Pa	
1-19-72	30 Min	8.0	.88	98		Pa	
1-20-72	5 Min	8.1	2.9	90		Pa	
1-20-72	30 Min	8.1	3.5	90		Pa	
2-18-72	5 Min	7.9	10	98	Clear	Pp	
4-28-72	2:30 p	7.6	2.6	98	—	P	
7-26-72	1 Min	8.0	7.	20	—	P	
	5 Min	7.9	7	2		P	
8-30-72	5 MIN	7.2	2.4	97		P	
	15 MIN	7.2	2.5	97		P	128

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PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well TH-11 **Date Drilled** Jan. 1972 **Depth** 57.2'

Diameter 6" **Casing Length** 57.2'

Screen Length — ~~Setting~~ Sealed 50.1'

Measuring Point Top of casing +1.7' above land surface

Elev. - Top of casing 658.75

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	Temp.		Elev.
1-19-72	1700	35	+2.23	37.23			621.52
1-20-72	0500	35	+2.02	37.02			621.73
1-27-72	0700	35	+2.30	37.30			621.45
2-8-72	0725	35	+2.07	37.07			621.65
2-8-72	1140	35	+2.12	37.12			621.63
2-8-72	1545	35	+2.09	37.09			621.66
2-9-72	0847	35	+2.10	37.10			621.65
2-18-72	225			37.00	58°F	SL	621.75
2-18-72	325			45.30	58°F	PL	613.45
6-30-72	1354	35	+2.05	37.05			621.70
7-11-72	2:40p	35	+1.98	36.98			621.77
7-26-72	1005	35	+2.11	37.11	57°	SL	621.64
		SEE	NEXT	Column			

CHEMICAL ANALYSIS

Date	Depth Time	~~Hold~~ pH	~~Sat~~ Fppm	% Trans ~~Growth~~	Color	Sample	Cl ppm.
1-18-72	50	7.6	2.8	95		B	
1-18-72	10 Sec	7.9	10.1	15		Pa	
1-18-72	30 Min	7.7	3.4	90		Pa	
1-18-72	1 hr	7.6	2.8	55		Pa	
1-18-72	50'	7.3	1.5	94		B	
1-18-72	57'	7.2	1.4	94		B	
1-20-72	5 Min	7.8	3.5	63		Pa	
1-20-72	30 Min	7.9	3.7	68		Pa	
2-18-72	10 Min	7.1	5	0	Gr-Brown	Pp.	
	30 Min	7.1	6	0	"	Pp	
4-28-72	1:30p	6.9	7.0	44			
7-25-72	1 Min	7.5	2.4	49		P	
	5 Min	7.3	2.4	58		P	
	15 Min	7.7	8.	60		P	142
8-25-72	5 MIN	7.4	4.3	83			
	30 MIN	7.8	4.5	65			117

DATE	TIME	Hold	CUT	DEPTH	TEMP		ElEV
8-25-72	1315	40	-2.26	37.74			621.01
8-30-72	0925	35	+2.30	37.30	60°		621.45
9-13-72	1140	35	+2.24	37.26			621.49

Broke Suction

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PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well TH-12 **Date Drilled** 2-16-72 **Depth** 74.0'

Diameter 6" **Casing Length** 74.0'

Screen Length — ~~Setting~~ Sounded 68.11

Measuring Point Top of Casing +3.0 above land surface

Elev. - Top of casing 638.55

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	Temp		Elev.
2-18-72	1030			35.61	55°F	SL	602.94
2-18-72	1130			35.77	55°F	PL	602.78
7-19-72	1810	35	+1.12	36.12		SL	602.43
7-19-72	1915	35	+1.72	36.72	57°F	PL	601.83
7-26-72	1445	35	+1.36	36.36			602.19
8-30-72	1725	35	+1.28	36.28			602.27
9-13-72	1337	35	+0.86	35.86			602.69

CHEMICAL ANALYSIS

Date	Depth Time	PH	F ppm	%Trans	Color	Sample	Cl ppm
2-14-72	65	7.2	.82	98	Clear	B	
	68	6.8	.51	98	Clear	B	
	68	7.2	.59	95	Clear	B	
2-18-72	30 Min	7.0	.92	98	Clear	Pp	
	60 Min	6.9	.82	97	Clear	Pp	
7-19-72	15 Min	6.9	.28	21	Tan	P	
	60 Min	6.9	.25	.25	Tan	P	19

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PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well TH-13 Date Drilled Feb. 1972 Depth 67.0'

Diameter 6" Casing Length 67.0'

Screen Length — ~~Setting~~ Sounded 60.4'

Measuring Point Top of Casing, 1.0 Ft. above land surface

Elev. Top of casing 631.30

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	Temp		Elev.
2-23-72	1010			28.40			602.90
7-26-72	1220	30	-1.88	28.12	55°	SL	603.18
7-26-72	1320	30	+2.37	32.37	56°	PL	598.93
8-30-72	1720	30	-1.26	28.74	—	—	602.56
9-13-72	1330	30	-1.58	28.42			602.88

CHEMICAL ANALYSIS

Date	~~Depth~~ Time	~~Hold~~ PH	~~Cut~~ Fppm	~~Depth~~ %Trans	Sample	Color	Cl ppm
2-15-72	5	6.2	2.	97			
2-16-72	38	6.3	.4	97	B	Clear	
	45	7.0	.5	97	B	Clear	
	55	7.2	.6	98	B	Clear	
	60	7.3	.7	97	B	Clear	
2-18-72	30 Min	7.0	.74	98	Pp	Clear	
	60 Min	7.1	.74	98	Pp	Clear	
7-25-72	15 Min	6.8	.15	53			
	60 Min	6.7	.15	73	P		79

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PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well TH-14 **Date Drilled** ______ **Depth** ______

Diameter 6" **Casing Length** ______

Screen Length ______ **Setting** ______

Measuring Point ______

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	Temp.		Elev.

CHEMICAL ANALYSIS

Date	Depth Time	~~Hold~~ PH	~~Cut~~ Fppm	%Trans ~~Depth~~	Sample	Color	Clppm
7-12-72	19-25	11.1	740	0	B	Liquid	
7-12-72	19-25	12.6	160	0	B	Brownish Soil	
7-13-72	49-55	9.9	22	0	B	Gray Slurry	

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Location HANNIBAL, OHIO

Well TH 14-A **Date Drilled** June 1972 **Depth** ______

Diameter 6" **Casing Length** ______

Screen Length 5' ~~Setting~~ Sounded 55.5'

Measuring Point Top of casing, +1.8' above land surface

Elev. Top of casing - 653.37

MEASUREMENTS:

The well is producing NH4 - very strong

Date	Time	Hold	Cut	Depth	Temp.		Elev.
7-26-72	1625	50	-2.08	47.92	69°	SL	605.45
7-25-72	1725	45	+3.54	48.54	69°	PL	604.83
8-25-72	1110	50	-0.07	49.93			603.44
8-30-72	0903	50	-0.21	49.79			603.58
9-13-72	1200	50	+0.08	50.08			603,29

CHEMICAL ANALYSIS

Date	Depth Time	PH	Fppm	%Trans	Sample	Color	Clppm
7-14-72	32-35	7.9	36	60	B	Black	
	45	12.2	450	0	B	Black	
	50	12.3	540	0	B	Black	
	55	12.3	310	0	B	Black	
	60	12.3	1180	0	B	Black	
7-17-72	50-54	10.3	950	0	B	Black	
	60-65	10.7	1175	0	B	Black	
	65-69	10.5	580	0	B	Black	122
7-25-72	1 Min.	10.5	1050	0	P		
	15 Min	10.5	1350	0	P		
	60 Min	10.5	1260	0	P		
8-30-72		10.0	600	80 ✓	Bailed		1897
		10.1	550	80 ✓	"		

SEE ABOVE ✓ = 1/10 DILUTION

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PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well 15 Date Drilled 7-4-72 Depth 102

Diameter 6" Casing Length

Screen Length 5' ~~Setting~~ Screened 96.81

Measuring Point Top of casing

Elev. Top of casing – 663.59

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	Temp		Elev.
7-11-72	1:55	75.	-2.37	72.63			590.96
7-18-72	1135	75	+.34	75.34		SL	588.21
7-18-72	1310	75	+.50	75.50	63°	PL	588.05
7-26-72	0740	75	+2.25	77.25	57°	SL	586.34
8-25-72	1040	80	+2.06	82.06			581.53
8-29-72	1555	80	+1.67	81.67	64°	SL	581.92
8-29-72	1800	80	+1.78	81.78	64°	PL	581.81
9-13-72	1115	79	+0.78	79.78			583.81

CHEMICAL ANALYSIS

Date	Depth Time	PH	Fppm	%Trans	Sample	Color	Clppm
6-30-72	82'	7.2	1.5	98	B		
	87'	7.5	2.2	98	B		
	92'	7.6	2.6	98	B		
	97'	7.7	2.7	98	B		
7-4-72	96-55' 11:30a	7.5	1.4	98	B	Screen Developed	
	1021 9:30a	8.0	1.8	98	B	Tan	
7-19-72	15 Min.	8.1	1.2	4	P	Tan	
	120 Min	8.1	1.0	87	P	Tan	
7-26-72	30	8.2	1.3	99	P		21
8-29-72	15	7.9	1.0	99			
	60	7.9	1.0	99			32

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PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well 16 **Date Drilled** 6-16-72 **Depth** 102

Diameter 6" **Casing Length**

Screen Length 5' ~~**Setting**~~ Sounded 97 - 102'

Measuring Point Top of 6" Casing 1.4 above land surface

Elev. Top Casing 664.32

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	Temp.		Elev
6-30-72	1430	75.0	+0.93	75.93	~~[illegible]~~		588.39
7-11-72	1:50p	75.0	-0.72	74.28			590.04
7-18-72	1408	75.0	+1.62	76.62		SL	587.20
7-18-72	1505	75.0	+2.50	77.50	57°	PL	586.82
7-26-72	0825	80.0	-1.51	78.49	57°	SL	585.83
8-25-72	1035	80.0	+2.99	82.99			581.33
8-29-72	1057	85.0	-2.30	82.70	59°	SL	581.62
8-29-72	1155	85.0	-1.48	83.52	59°	PL	580.80
9-13-72	1050	80	+1.44	81.44			582.88

CHEMICAL ANALYSIS

Date	Depth Time	PH	F ppm	% Trans.	Sample	Color	Cl ppm
6-14-72	97' 9:30	8.0	1.8	95	B		
6-14-72	97' 0945	8.1	1.8	97	B		
6-15-72	97-102' 1100	8.1	1.2	93	B		
6-15-72	102 1130	8.2	1.3	90	B		
6-20-72	10 min 1325	7.9	1.4	90	P		
6-20-72	30 min	8.1	1.3	93	P		
6-20-72	60 min	8.2	1.1	95	P		
6-20-72	105 min	8.3	1.1	99	P		
7-18-72	15 min	8.6	1.1	96	P	Clear	
	60 min	8.2	1.0	98	P	Clear	27
7-26-72	30 min	8.2	1.1	99	P		
8-29-72	15 min	8.1	1.3	98	P		
8-29-72	60 min	8.2	1.3	98	P		27

FRED H. KLAER, JR. & ASSOCIATES
COLUMBUS, OHIO

PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well 17 **Date Drilled** 6-20-72 **Depth**

Diameter 6" **Casing Length**

Screen Length 5' ~~Setting~~ Sounded

Measuring Point Top of Casing 2.1' Above Land Surface

Elev. Top of casing 663.55

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	Temp.		Elev.
6-30-72	1423	75.0	+1.14	76.14			589.41
7-11-72	1:45P	75.0	-1.12	73.88			589.67
7-18-72	1645	75.0	+.84	75.84		SL	587.71
7-18-72	1750	75.0	+2.20	77.20	58°	PL	586.35
7-26-72	0905	75.0	+2.88	77.88	58°	SL	585.67
8-05-72	1030	80.0	+2.40	82.40			581.15
8-29-72	1540	80.0	+2.08	82.08	58°	SL	581.47
8-29-72	1715	80.0	-1.53	83.47	58°	PL	580.08
9-13-72	1045	80.0	+1.30	81.30			582.25

CHEMICAL ANALYSIS

Date	Depth Time	PH	Fppm	%Trans	Sample	Color	Clppm
6-19-72	1345 85'	7.9	2.4	88	B		
6-19-72	1500 90'	7.7	0.64	85	B		
6-19-72	1530 91'	7.9	0.60	80	B		
6-22-72	9:00a 85-90	7.9	0.78	70*	B		
7-18-72	15 Min	7.4	.02	30	P	Tan	
	60 Min	7.4	<0.16	93	P	Clear	39
7-25-72	30 Min	7.4	.15	97	P		
8-29-72	15 Min	7.3	0.5	98			
	60 Min	7.3	0.9	99			34

* No Dilution

FRED H. KLAER, JR. & ASSOCIATES
COLUMBUS, OHIO

PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well 18 **Date Drilled** ______ **Depth** ______

Diameter ______ **Casing Length** ______

Screen Length ______ ~~**Setting**~~ Sounded ______

Measuring Point Elev. Ground Level 660.76'

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	Temp.		Elev.

CHEMICAL ANALYSIS

Date	Depth Time	PH	Eppm Cut	%Trans Depth	Sample	Color	Clppm

FRED H. KLAER, JR. & ASSOCIATES
COLUMBUS, OHIO

PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well 19 **Date Drilled** ______ **Depth** ______

Diameter ______ **Casing Length** ______

Screen Length ______ ~~Setting~~ Sounded 7-18-72 98.2

Measuring Point Top of Casing 1.8' above land surface

Top of Casing 662.63 Elevation

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	Temp.		Elev.
7-11-72	1:35P	75.0	-0.93	74.07			588.56
7-18-72	1525	75.0	+1.12	76.12		SL	586.51
7-18-72	1630	75.0	+2.04	77.04	55°	PL	585.59
7-26-72	1040	80.0	+2.20	77.80	56°	SL	584.83
8-25-72	1025	80.0	+2.19	82.19			580.44
8-29-72	1305	80.0	+1.75	81.75	58°	SL	580.88
8-29-72	1405	80.0	+2.78	82.78	58°	PL	579.85
9-13-72	1055	80.0	+1.00	81.00			581.63

CHEMICAL ANALYSIS

Date	Depth Time	PH	F ppm	% Trans Depth	Sample	Color	Cl ppm
7-9-72	20-34'	7.5	.64	92	B		
7-10-72	80'	7.8	.76	94	B		
7-10-72	85'	7.7	.64	94	B		
7-10-72	90'	7.8	.82	95	B		
7-10-72	95'	7.9	.99	95	B		
7-11-72	100'	7.7	1.8	96	B		
7-11-72	95-100'	7.9	1.8	95	B	Screen Developed	
7-18-72	15 Min	8.0	1.2	29	P	Tan	
	60 Min	8.0	1.3	96	P	Clear	29
7-26-72	30 Min	8.1	1.1	99	P		
8-29-72	15 Min	7.9	1.7	99	P		
	60 min	8.0	1.5	99	P		28

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COLUMBUS, OHIO

PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well PW 8" **Date Drilled** Jan. 1972 **Depth** 92.0

Diameter 8" **Casing Length** 92.0

Screen Length — ~~Setting~~ Sounded Depth 87.0

Measuring Point Top of casing 20' above land Surface

Top of casing 654.25 Elevation

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	Temp.		Elev.
1-26-72	1430	50	+1.51	51.51			602.74
1-27-72	0830	50	+1.42	51.42			602.83
2-8-72	1711	50	+2.28	52.28		SL	601.70
2-16-72	1820	50	+2.75	52.75		PL	601.50
6-30-72	1336	40	-1.04	38.96			615.29
7-11-72	2:55p	45	-0.57	44.43			609.82
7-19-72	1435	50	1.10	48.90		SL	605.35
7-19-72	1545	50	.41	49.59	56°	PL	604.66
7-26-72	1355	50	+.07	50.07			604.18
8-25-72	1118	50	+1.92	51.92			602.33
8-30-72	1115	50	+1.65	51.65	59°	SL	602.60
9-13-72	1210	50	+1.78	51.78			602.47

CHEMICAL ANALYSIS

Date	Depth Time	PH	Fppm	%Trans Depth	Sample	Color	Clppm
1-20-72	50	10.2	580	0	B		
1-20-72	55	10.2	580	0	B		
1-20-72	60	10.2	600	0	B		
1-20-72	75	10.2	670	0	B		
1-21-72	70	10.6	1100	0	B		
1-21-72	75	10.6	1025	0	B		
1-21-72	80	10.6	1025	0	B		
1-21-72	90	10.7	1050	0	B		
1-21-72	95	10.6	1025	0	B		
1-26-72	P.T. PR ELIM	10.5	690	0	P	Black	
1-26-72	1 Min	10.1	420	0	P	"	
1-26-72	30 Min	10.5	770	0	P	"	
1-26-72	1 Hr.	10.5	720	0	P	"	
1-26-72	2 Hrs.	10.3	690	0	P	"	
2-8-72	10 Min	10.5	720		P	"	
	100 Min	10.5	720		P	"	
	2 Hrs	10.5	720		P	"	
	4 Hrs	10.5	720		P	"	
	6 Hrs	10.4	740		P	"	
	8 Hrs	10.4	770		P	"	
	12 Hrs	10.4	740		P	"	
	14 Hrs	10.4	740		P	"	
	16 Hrs	10.4	720		P	"	
	18 Hrs	10.4	720		P	"	
	20 Hrs	10.4	720		P	"	
	22 Hrs	10.4	720		P	"	
	24 Hrs	10.6	670		P	"	
2-16-72	30 Min	10.1	560	0	P	"	

FRED H. KLAER, JR. & ASSOCIATES
COLUMBUS, OHIO

PROJECT ORMET CORPORATION

Location HANNIBAL, OHIO

Well PW-8" **Date Drilled** ______ **Depth** ______

Diameter ______ **Casing Length** ______

Screen Length ______ **Setting** ______

Measuring Point ______

MEASUREMENTS:

Date	Time	Hold	Cut	Depth	Temp.		Elev.

CHEMICAL ANALYSIS

Date	Depth Time	PH [redacted]	Fppm	%Trans Depth	Sample	Color	Clppm
2-16-72	60 Min.	10.2	550	0	P	Black	
4-4-72	4¾ Hrs.	10.9	850	50			
4-27-72	10:45am	10.5	700	95 ✓	P	Dark	
4-28-72		10.8	850	37	P	–	
5-2-72	4½ Hrs	10.9	700	50			
5-2-72	5½ Hrs	10.9	690	44			
5-18-72		10.7	485	96 ✓			
6-26-72		10.1	300	92 ✓	P	Black	
7-19-72	15 Min.	10.7	585	78	P	Lt. Br.	4050
7-19-72	60 Min	10.7	585	74	P	Lt. Br.	4100
8-24-72		10.1	340		P	Black	2766
8-30-72	15	10.2	260	94*			
	60	10.2	280	94*			3528

✓ 1/100 Dilution

PHASE 3 - RANNEY WELL

LATERAL TEST

ORMET CORPORATION

For

THE ORMET CORPORATION
ALUMINUM REDUCTION DIVISION
HANNIBAL, OHIO

By

FRED H. KLAER, JR. & ASSOCIATES
CONSULTING GEOLOGISTS AND HYDROLOGISTS
COLUMBUS, OHIO

November 3, 1972

TABLE OF CONTENTS

SYNOPSIS

INTRODUCTION:

The results of a detailed hydrogeological survey of the Ormet plant water supply have been presented in a report entitled, "Hydrogeological Survey of Plant Water Supply, 1972, dated March 1, 1972 and a second report entitled, "Phase 2, Hydrogeological Survey of Plant Water Supply, 1972, Ormet Corporation", dated September 27, 1972.

One of the recommendations of the Phase 2 report was that a detailed pumping test of the Ranney well should be made to determine which laterals were contributing the major part of the contamination to the Ranney well. Since the well cannot be shut down and pumped with only one lateral at a time open, it is necessary to obtain the necessary information by closing one or more laterals at a time and noting the change in chemical quality in the water produced by the other open laterals. The detailed pumping test was run on October 9-12, 1972 and the results are described in the following report. The work under Phase 3 was authorized by Ormet Purchase Order No. OH-076529, dated October 9, 1972.

SUMMARY AND CONCLUSIONS:

1. A detailed pumping test of the Ranney well was made on October 9-12, 1972, during which each lateral except lateral 4, was closed for a period of about 4 hours and changes in pumping level in the well and in the chemical quality of the water pumped were measured. Following the reopening of the lateral, the well was pumped for about 2 hours to reestablish the normal chemical quality. Lateral 7 was turned off for 8 hours. During the last 4 hours, lateral 6 was also closed and remained closed for 4 hours

after lateral 7 was opened. Following the closing of individual laterals, laterals 6, 7 and 8 were all closed for a period of about 8 hours and lateral 7 remained closed for an additional 15¼ hours. The pumping rate during the test remained constant at 1850 gpm and the pumping level ranged from a depth to water of 82.39 to 82.74 feet below the pumphouse floor.

2. The results of the test indicated that the major portion of the contaminated water was being contributed by lateral 7 with perhaps a minor amount being contributed by lateral 6.

3. This suggests that the contamination is reaching the Ranney well in a relatively narrow zone from the land side, the limits of which cannot be determined from the information available at this time.

4. It is our opinion that it may be possible to intercept the flow of contaminated water to the Ranney well by installing and pumping to waste an interceptor well in the area north of the Ranney well. Although we cannot guarantee that the pumping of an interceptor well will be 100 percent successful, it is our opinion that considering the costs of alternative solutions, the proposed interceptor well plan is a reasonable gamble.

5. The proposed well should be a 12-inch diameter well about 100 feet deep and should be equipped with 10 feet of stainless steel commercial well screen. The well should be thoroughly and properly developed to minimize well losses. The well will be equipped temporarily with an electric deep well turbine pump, control valve, measuring orifice and discharge piping to conduct the water pumped to some point of waste.

6. A detailed pumping test will be run during which water samples will be collected at frequent intervals for analysis by Ormet personnel from the interceptor well, the Ranney well and T.H. O. Water level recorders will be installed on T.H. 1 and T.H. 15. The test will be run at least one week and may be run as long as 4 weeks.

7. If the proposed pumping test is successful in eliminating or reducing the contamination of the Ranney well water to acceptable standards for industrial use or disposal to the Ohio River, the well should be equipped with a permanent pump, discharge valve and flow meter and permanent piping to conduct the water pumped to a point of use or treatment. The water pumped will be of poorer chemical quality than that of the Ranney well at the present time. Continuous pumping over an indefinite period of time will be required to protect the Ranney well.

Respectfully submitted,

FRED H. KLAER, JR. & ASSOCIATES
CONSULTING GROUND-WATER GEOLOGISTS & HYDROLOGISTS

by Fred H. Klaer Jr.
Fred H. Klaer, Jr.
Certified Professional Geologist No. 75
Registered Geologist(California) No.17

FHKJr/eh

REPORT

RANNEY WELL LATERAL TEST:

On October 9, 1972, a pumping test was started at 10:35 a.m., during the normal continuous pumping of the Ranney well. Water levels in the Ranney well were measured by electric tape from the top of the metal rim around the square access manhole in the pump floor, 7.72 feet above the lower slab. The elevation of the measuring point was 666.7 feet above mean sea level. Readings of the flow meter chart were read and during the test the flow meter chart showed a constant pumping rate of about 1850 gpm. Readings of the Ormet water level recorder were made at frequent intervals and showed consistent readings of 13.2 to 13.9 feet above elevation 572 feet above mean sea level. It is reported that the Ormet water level recorder is accurate to the nearest ½ foot.

During the test, each lateral was turned off for about 4 hours, and water levels were measured at ½ to 1 hour intervals. Lateral 4 could not be closed because of a broken valve stem extension. Samples of water were obtained from the sampling tap, which was connected to a 5 gallon glass bottle, the overflow from which was siphoned back into the collector. A total of 61 water samples were obtained at approximately 1 hour intervals.

Following a 4-hour period during which one lateral was closed, the Ranney well was pumped for about a two hour period with all laterals open to re-establish the normal quality of the water pumped. The record sheet for the test is shown in Table 1 at the end of the report. The results of the chemical analyses are presented in Table 2. The lateral pattern of the Ranney well is shown in Figure 1 and the results of the test are shown in Figure 2.

CHANGES IN CHEMICAL QUALITY:

In Figure 2, an improvement in the chemical quality of the Ranney well water, indicated by a decrease in pH and fluoride content and an increase in percent transmittance, is shown by an upward trend in the graphs.

A study of Figure 2 shows that the major changes in chemical quality usually occur within ½ to 1 hour after an individual lateral is closed or opened. This indicates that the elimination or addition of water contributed by an individual lateral is picked up or lost by the adjacent laterals within a short period of time. It must be remembered that with a pumping level at elevation 584 feet above mean sea level, about 20,000 gallons of water are stored in the Ranney well and the immediate changes are diluted to a considerable extent by the water in the caisson. This amount of water is equivalent to about 11 minutes pumping at 1850 gpm.

It should be noted that following the closing individually of laterals 8,5,3,2, and 1, the graphs show generally an increase in pH and fluoride content and a decrease in percent transmittance. This indicates a decrease in uncontaminated water entering the Ranney well, diminishing the dilution of the contaminated water.

The closing of lateral 7 individually caused the greatest improvement in chemical quality shown by closing individual laterals and indicates that lateral 7 is contributing the major part of the contaminated water.

The closing of lateral 6 with lateral 7 closed caused a slight improvement in chemical quality. However, when lateral 7 was opened with lateral 6 still closed, the chemical quality deteriorated rapidly, showing that the effect of lateral 7 is much greater than that of lateral 6. The improvement in quality when lateral 6 was closed suggests that lateral 6 may be contributing a small part of the contaminated water.

After the laterals had been closed and opened individually, laterals 6,7, and 8 were closed for a period of about 8 hours. The maximum improvement in chemical quality, as shown by Sample 53, occurred within 3/4 hour after the closing of the three laterals when the pH was reduced to 8.7, the fluoride to 6 ppm, and the transmittance was raised to 85 percent. Following this improvement, the quality deteriorated during the next 7¼ hours, when all three laterals were closed.

Laterals 6 and 8 were opened at 1645 on October 11, and pumping was continued with lateral 7 closed until 805 on October 12. During the last 15½ hours of the test, while lateral 7 only was closed the quality continued to deteriorate slowly.

CHANGES IN WATER LEVEL:

The measurements of water level in the Ranney well during the test showed that the closing of any one lateral affected the pumping level less than 0.15 foot. The lowering of water level caused by closing individual laterals 6,7, and 8 was 0.08 to 0.09 foot, while the lowering of water caused by closing laterals 1,2,3 and 5 was 0.9 to 0.12 foot. The two laterals producing the most water appear to be laterals 2 and 5, each producing about 15 percent of the total water pumped. During the test the river rose from a stage of 15.0 feet at 7:00 a.m. on October 9 to a stage of 15.8 feet at 7:00 on October 12, 1972.

The lowest observed water level reached during the test occurred at 10:30 a.m. on October 11, about 1 hour and 40 minutes after laterals 6,7, and 8 were closed. As the flow pattern readjusted to the new conditions, pumping levels rose about 0.1 foot during the next 6 hours.

In our report on Phase 2 of the investigation, we included a diagram showing generalized contours of the water table shown in Figure 5. A reanalysis of the general flow pattern considering to a greater extent the infiltration of water from the Ohio River changed the contours and flow lines to some extent. A revised diagram of the contours and flow lines is shown in Figure 5,Revised, in this report.

GENERAL CONCLUSIONS:

The results of the lateral test of the Ormet Ranney well show that the major part of the contaminated water is entering the well through lateral 7, with possibly a minor amount of contaminated water being contributed by lateral 6. The closing of lateral 7 will not eliminate the contamination as the contaminated water will move to an adjacent lateral within a short period of time, generally within ½ to 1½ hours.

The closing of laterals 1,2,3,5, and 8 individually resulted in a deterioration of chemical quality indicating that these laterals were contributing uncontaminated water, which when eliminated, decreased the dilution of the bad water entering the well through lateral 7.

The fact that the closing of lateral 7 results in a major improvement in chemical quality indicates that the contaminated water is moving toward the Ranney well through a relatively narrow zone, the exact limits of which cannot be determined at this time.

POSSIBLE INTERCEPTION OF THE CONTAMINATED WATER:

It is our opinion that it may be possible to intercept the flow of contaminated water to the Ranney well by installing a vertical well in the area north of the Ranney well near the outer end of lateral 7. The pumping of the interceptor well will create a cone of depression which should intercept the flow of contaminated water and prevent it from reaching the Ranney well. The interception of a major part of the contaminated water should improve the chemical quality of the Ranney well water to acceptable limits for industrial use and for disposal to the Ohio River.

The information available is not adequate to pinpoint the limits of the zone through which the contaminated water is reaching the well nor to map in detail the flow lines of ground water movement in the vicinity of the Ranney well. However, considering the costs of alternative solutions to the problem, the use of an interceptor well to diminish or eliminate the contamination of the Ranney well water is considered to be a reasonable gamble. We cannot, however, guarantee that the plan will be 100 percent successful.

RECOMMENDED DESIGN OF INTERCEPTOR WELL:

We recommend that a 12-inch diameter well be installed at a location to be selected on the site north of the Ranney well, to be equipped with 10 feet of nominal 12-inch diameter stainless steel well screen. The well will be approximately 100 feet deep. We anticipate that the saturated portion of the aquifer will be about 20 feet.

The well should be properly and thoroughly developed to remove the fine materials from the aquifer surrounding the well screen, and to minimize the well losses inside the well.

The well should be equipped with a temporary deep well turbine pump capable of pumping up to 500 gpm against a total discharge head of at least 150 feet. The pump should be equipped with a control valve on the pump discharge and a proper sized orifice tube and free discharge orifice so that the pumping rate can be measured. A temporary pipe line will be required to conduct the water pumped to some point of wastage.

The pump will be electrically powered and we understand that power (440 volt, 3 phase, 60 cycle) can be made available at the site by Ormet.

RECOMMENDED PUMPING TEST:

A pumping test should be run for a period of at least one week and perhaps for several weeks at several different pumping rates to determine the minimum pumping rate that is required to intercept successfully the contaminated water. Water samples should be collected from the interceptor well, the Ranney well, and T.H. O. Automatic water level recorders should be installed on T.H. 1 and T.H. 15.

During the first day of pumping, water samples should be collected at ½ hour intervals during the first 2 hours, at 2-hour intervals for the next six hours and twice a day during the remainder of the test. The frequency of sampling may be changed based on the observed changes in chemical quality.

PERMANENT INTERCEPTOR WELL INSTALLATION:

Assuming that the pumping test described above shows that the contamination can be intercepted successfully by an interceptor well, the well should be equipped with a permanent electric pump, the cost of which is estimated as about $3000, which should be equipped with a control valve and flow meter. The water pumped will have to be carried by pipe line to some point of use or treatment before disposal into the river. The chemical quality of the water is expected to be more highly contaminated than that from the Ranney well at the present time. It must be realized that the interceptor well will have to be pumped continuously for an indefinite period of time to be successful in minimizing the contamination of the Ranney well water.

It may become necessary to change the pumping rate from the interceptor well during severe changes in river stage and it is our opinion that the permanent pump should be capable of pumping up to 500 gpm if necessary.

The use of the interceptor well pumping continuously to waste will probably reduce the capacity of the Ranney well to some degree. We believe, however, that the reduction in capacity in the Ranney well will be less than the amount of water pumped from the interceptor well.

The proposed use of an interceptor well if successful in minimizing the contamination of the Ranney well water will permit the continued use of the Ranney well, which produces water with a temperature lower than that of river water during most of the year, and will add to the barrier effect of the Ranney well in preventing the possible flow of contaminated water toward the Omal Ranney well.

TABLE 1
ORMET RANNEY WELL LATERAL TEST
October 9-12,1972

Date	Time	Depth to Water	Pumping Rate gpm.	Recorder W.Level ft.	Sample No.	Laterals Off
10/09/72	1035	82.39	1860	13.8	1	None
	1055	82.41	1850	13.8		"
	1113	82.41	1850	13.9	2	"
	1150	82.40	1850	13.9		"
	1220				3	"
	1345	82.40				
	1400					#8 Closed
	1405	82.45	1850	13.7		"
	1430	82.45	1850	13.7	4	"
	1445	82.47	1850	13.8		"
	1530	82.46	1850	13.8		"
	1600	82.48	1850	13.8	5	"
	1630	82.48	1850	13.8		"
	1700	82.49	1850	13.6	6	"
	1800	82.51	1850	13.6	7	"
	1815					#8 Opened
	1830	82.45	1850	13.7		None
	1900	82.45	1850	13.7	8	"
	2000	82.44	1850	13.7	9	"
	2015					#7 Closed
	2030	82.49	1850	13.5	10	"
	2100	82.50	1850	13.6	11	"
	2130	82.50	1850	13.6		"
	2200	82.52	1850	13.5	12	"
	2230	82.53	1850	13.5		"
	2300	82.52	1850	13.5	13	"
	2330	82.53	1850	13.4		"
	2400	82.51	1850	13.4	14	"
10/10/72	0008					#6 Closed
	2415	82.54	1850	13.5		7&6
	2430	82.53	1850	13.5	15	"
	0100	82.54	1850	13.5	16	"
	0200	82.53	1850	13.5	17	"
	0300	82.53	1850	13.5	18	"
	0400	82.55	1850	13.5	19	"
	0430					#7 Opened
	0445	82.53	1850	13.5	20	#6

TABLE 1 (Continued)
ORMET RANNEY WELL LATERAL TEST
October 9-12, 1972

Date	Time	Depth to Water	Pumping Rate gpm.	Recorder W.Level ft.	Sample No.	Laterals OFF
10/10/72	0500	82.50	1850	13.5	21	#6
	0600	82.50	1850	13.5	22	"
	0700	82.49	1850	13.5	23	"
	0820	82.48			24	"
	0845					#6 Opened
	0900	82.49				
	0915	82.48	1850	13.5	25	None
	0945	82.49			26	"
	1015				27	"
	1025					#5 Closed
	1040	82.55	1850	13.5	28	"
	1100	82.57			29	"
	1125	82.58	1850	13.5		"
	1205	82.58	1850	13.4	30	"
	1230	82.57	1850	13.4		"
	1300	82.55	1850	13.4	31	"
	1330	82.58	1850	13.0		"
	1400	87.58	1850	13.0	32	"
	1400					#5 Opened
	1430	82.45	1850	13.6		None
	1500	82.46	1850	13.6	33	"
	1600	82.52	1850	13.6	34	"
	1600					#3 Closed
	1630	82.53	1850	13.6	35	"
	1700	82.55	1850	13.6		"
	1800	82.55	1850	13.8	36	"
	1900	82.53	1850	13.6	37	"
	2000	82.54	1850	13.5	38	"
	2000					#3 Opened
	2100	82.47	1850	13.2	39	None
	2200	82.48	1850	13.2	40	"
	2200					#2 Closed
	2300	82.57	1850	13.5	41	"
	2400	82.60	1850	13.5	42	"
10/11/72	0100	82.58	1850	13.5	43	"
	0200	82.58	1850	13.5	44	"
	0210					#2 Opened

TABLE 1 (Continued)
ORMET RANNEY WELL LATERAL TEST
October 9-12, 1972

Date	Time	Depth to Water	Pumping Rate gpm.	Recorder W. Level Ft.	Sample No.	Laterals Off
10/11/72	0230	82.48	1850	13.5	45	None
	0300	82.49	1850	13.5	46	"
	0400	82.50	1850	13.5	47	"
	0408					#1 Closed
	0430	82.56	1850	13.5	48	"
	0515	82.57	1880	13.5	49	"
	0600	82.58	1850	13.5	50	"
	0800	82.58	1850	13.5	51	"
	0820					#1 Opened
	0850					#6,7,8 Closed
	0900	82.71	1850	13.5	52	"
	0930	82.71	1850	13.5	53	"
	1030	82.74	1850	13.5	54	"
	1130	82.70	1850	13.5	55	"
	1230	82.70	1850	13.3	56	"
	1330	82.65	1850	13.2	57	"
	1430	82.65	1850	13.2	58	"
	1530	82.64	1850	13.2	59	"
	1630	82.64	1850	13.2	60	"
	1645					#6 & 8 Opened
10/12/72	0805	82.47	1850	13.2	61	7

TABLE 2
ORMET RANNEY WELL LATERAL TEST
October 9-12,1972

CHEMICAL ANALYSES

Date	Sample No.	Time	Transmittance %	Fluoride ppm	pH	Laterals Off
10/09/72	1	1035	30	24	9.0	None
	2	1120	34	24	9.1	"
	3	1220	31	22	9.1	"
	4	1430	27	26	9.1	#8
	5	1600	25	27	9.1	"
	6	1700	25	27	9.1	"
	7*	1800	24	27	9.1	"
	8	1900	55	23	9.3	None
	9	2000	48	22	9.2	"
	10	2030	73	13	9.0	#7
	11	2100	74	12	9.0	"
	12	2200	70	14	9.0	"
	13	2300	66	15	9.1	"
	14	2400	65	16	9.1	"
10/10/72	15	0030	70	13	9.1	#6&7
	16	0100	70	13	9.1	"
	17	0200	68	14	9.1	"
	18	0300	66	15	9.2	"
	19	0400	65	16	9.2	"
	20	0445	38	29	9.4	#6
	21	0500	39	29	9.4	"
	22	0600	42	28	9.4	"
	23	0700	43	28	9.4	"
	24	0820	47	27	9.4	None
	25	0912	52	24	9.3	"
	26	0945	51	24	9.3	"
	27	1015	25	24	9.1	"
	28	1040	21	27	9.1	#5
	29	1100	22	26	9.1	"
	30	1205	22	26	9.1	"
	31	1300	22	26	9.1	"
	32	1400	22	26	9.1	"
	33	1500	25	24	9.1	None
	34	1600	25	24	9.1	"
	35	1630	21	25	9.1	#3

TABLE 2 (Continued)
ORMET RANNEY WELL LATERAL TEST
October 9-12, 1972

CHEMICAL ANALYSES

Date	Sample No.	Time	Transmittance %	Fluoride ppm.	pH	Laterals Off
10/10/72	36	1800	22	25	9.1	#3
	37	1900	22	25	9.0	"
	38	2000	23	24	9.0	"
	39	2100	24	24	9.0	"
	40	2200	23	24	9.0	"
	41	2300	21	24	9.0	#2
	42	2400	20	25	9.0	"
10/11/72	43	0100	19	25	9.0	"
	44	0200	20	24	9.0	"
	45	0230	24	24	9.0	None
	46	0300	23	24	9.0	"
	47	0400	26	22	9.0	"
	48	0430	20	26	9.0	#1
	49	0515	23	26	9.1	"
	50	0630	22	26	9.1	"
	51	0811	22	26	9.1	"
	52	0900	72	12	9.1	6,7,&8
	53	0930	85	6	8.7	"
	54	1030	84	6	8.7	"
	55	1130	78	7.4	8.8	"
	56	1230	75	8.2	8.9	"
	57	1330	72	8.8	8.9	"
	58	1430	71	9.6	8.9	"
	59	1530	70	10	8.9	"
	60	1630	68	10.4	8.9	"
10/12/72	61	0800	55	20	9.2	#7

Analysis by Ormet personnel.

TABLE 2
ORMET RANNEY WELL LATERAL TEST
October 9-12, 1972

CHEMICAL ANALYSES

Date	Sample No.	Time	Transmittance %	Fluoride ppm	pH	Laterals Off
10/09/72	1	1035	30	24	9.0	None
	2	1120	34	24	9.1	"
	3	1220	31	22	9.1	"
	4	1430	27	26	9.1	#8
	5	1600	25	27	9.1	"
	6	1700	25	27	9.1	"
	7*	1800	24	27	9.1	"
	8	1900	55	23	9.3	None
	9	2000	48	22	9.2	"
	10	2030	73	13	9.0	#7
	11	2100	74	12	9.0	"
	12	2200	70	14	9.0	"
	13	2300	66	15	9.1	"
	14	2400	65	16	9.1	"
10/10/72	15	0030	70	13	9.1	#6&7
	16	0100	70	13	9.1	"
	17	0200	68	14	9.1	"
	18	0300	66	15	9.2	"
	19	0400	65	16	9.2	"
	20	0445	38	29	9.4	#6
	21	0500	39	29	9.4	"
	22	0600	42	28	9.4	"
	23	0700	43	28	9.4	"
	24	0820	47	27	9.4	None
	25	0912	52	24	9.3	"
	26	0945	51	24	9.3	"
	27	1015	25	24	9.1	"
	28	1040	21	27	9.1	#5
	29	1100	22	26	9.1	"
	30	1205	22	26	9.1	"
	31	1300	22	26	9.1	"
	32	1400	22	26	9.1	"
	33	1500	25	24	9.1	None
	34	1600	25	24	9.1	"
	35	1630	21	25	9.1	#3

TABLE 2 (Continued)
ORMET RANNEY WELL LATERAL TEST
October 9-12, 1972

CHEMICAL ANALYSES

Date	Sample No.	Time	Transmittance %	Fluoride ppm.	pH	Laterals Off
10/10/72	36	1800	22	25	9.1	#3
	37	1900	22	25	9.0	"
	38	2000	23	24	9.0	"
	39	2100	24	24	9.0	"
	40	2200	23	24	9.0	"
	41	2300	21	24	9.0	#2
	42	2400	20	25	9.0	"
10/11/72	43	0100	19	25	9.0	"
	44	0200	20	24	9.0	"
	45	0230	24	24	9.0	None
	46	0300	23	24	9.0	"
	47	0400	26	22	9.0	"
	48	0430	20	26	9.0	#1
	49	0515	23	26	9.1	"
	50	0630	22	26	9.1	"
	51	0811	22	26	9.1	"
	52	0900	72	12	9.1	6,7,&8
	53	0930	85	6	8.7	"
	54	1030	84	6	8.7	"
	55	1130	78	7.4	8.8	"
	56	1230	75	8.2	8.9	"
	57	1330	72	8.8	8.9	"
	58	1430	71	9.6	8.9	"
	59	1530	70	10	8.9	"
	60	1630	68	10.4	8.9	"
10/12/72	61	0800	55	20	9.2	#7

Analysis by Ormet personnel.

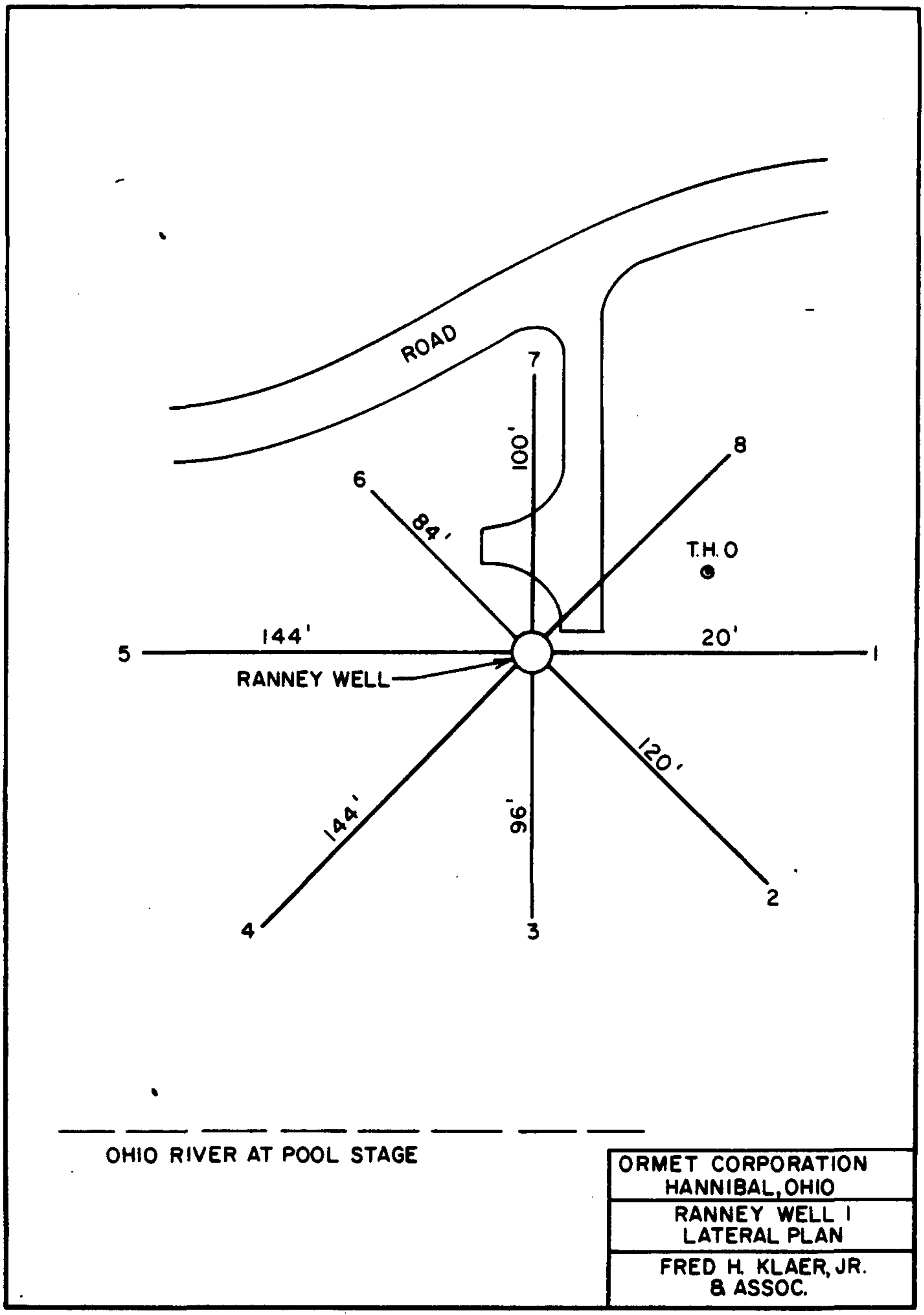

ROAD
7
100'
8
6
84'
T.H. O
144'
20'
5
1
RANNEY WELL
120'
144'
96'
2
4
3
OHIO RIVER AT POOL STAGE
ORMET CORPORATION
HANNIBAL, OHIO
RANNEY WELL 1
LATERAL PLAN
FRED H. KLAER, JR.
& ASSOC.

FIGURE 1

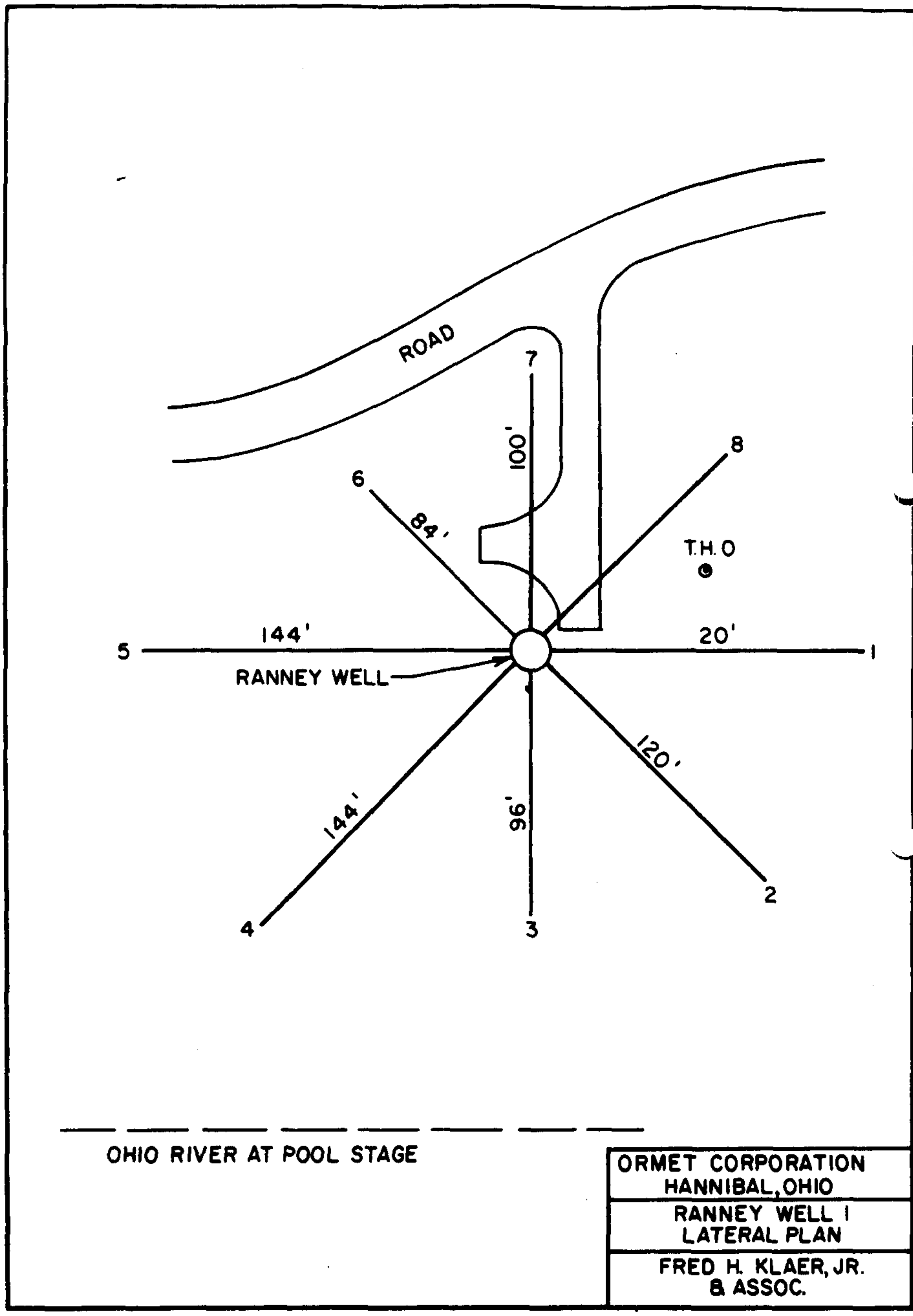

ROAD
7
100'
8
6
84'
T.H. O
144'
20'
5
1
RANNEY WELL
120'
144'
96'
2
4
3
OHIO RIVER AT POOL STAGE
ORMET CORPORATION
HANNIBAL, OHIO
RANNEY WELL 1
LATERAL PLAN
FRED H. KLAER, JR.
& ASSOC.

FIGURE 1

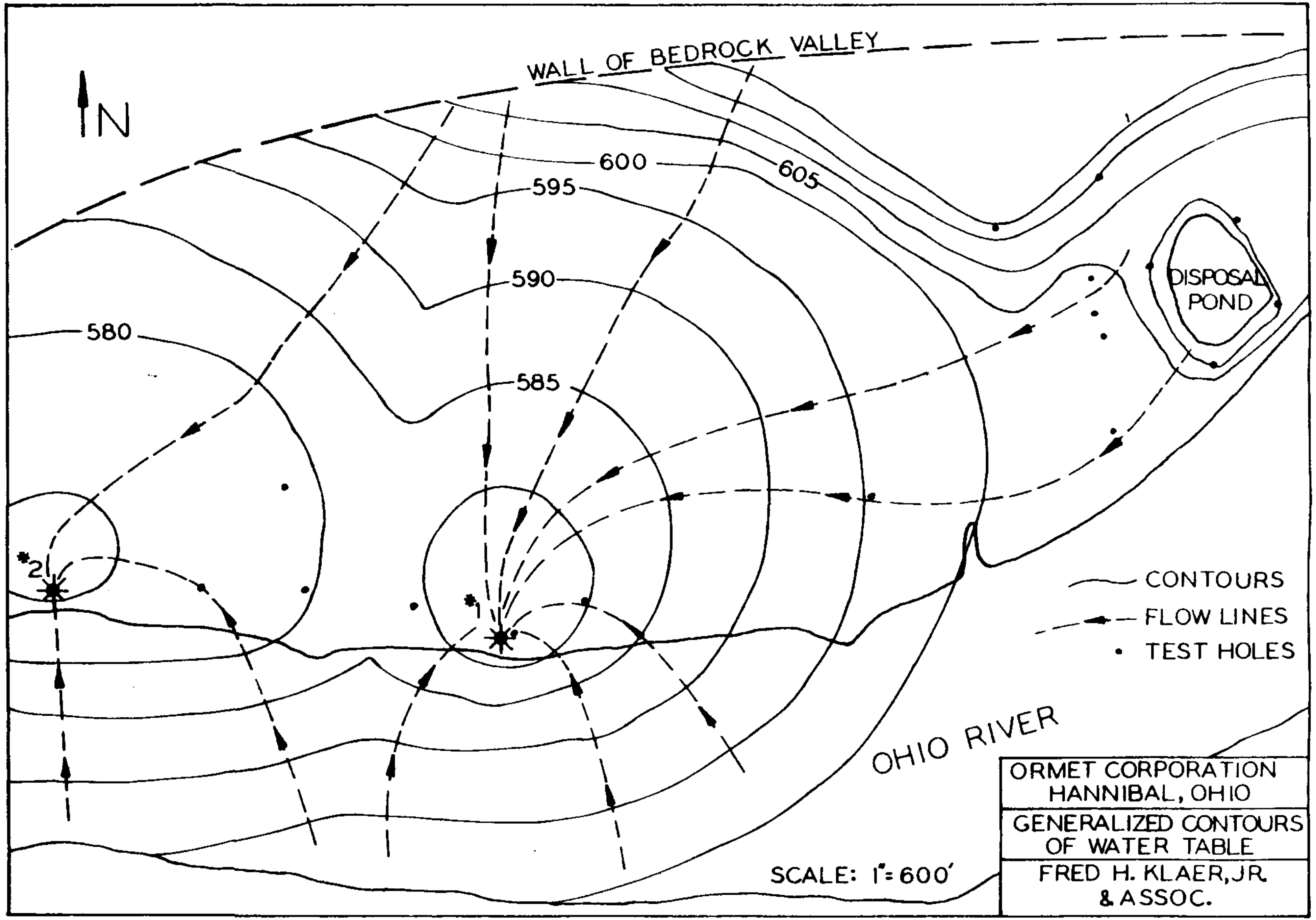


FIGURE 5 (REVISED)

1

S.M.B.
B. Paidock

ORMET CORPORATION
Reduction Division

ANALYTICAL LABORATORY

OR 62 Rev. 1066

SAMPLE: Water REPORT NO.

DESCRIPTION: Special - Effect of closing laterals at Ranney Well DATE: 10/10/72

RECEIVED FROM: Ranney Well

	% Trans.	PPM F⁻	pH		
No. 1	30	24	9.0	10-9-72 10:35AM	All of
2	34	24	9.1	11:20	
3	31	22	9.1	12:20	" "
4	27	26	9.1	14:30	"8 OF
5	25	27	9.1	16:00	"
6	25	27	9.1	17:00	"
7+	24	27	9.1	18:00	"
8	55	23	9.3	19:00	All o
9	48	22	9.2	20:00	"
10	73	13	9.0	20:30	7 0
11	74	12	9.0	21:00	"
12	70	14	9.0	22:00	"
13	66	15	9.1	23:00	"
14	65	16	9.1	24:00	"
15	70	13	9.1	10-10-72 00:30	"6+7 0

Analyzed By: AP Approved By: W Date: 10/11/72

(2)

J. M. B.,
B. Paidock/3,

ORMET CORPORATION
Reduction Division

ANALYTICAL LABORATORY

OR 62 Rev. 1066

SAMPLE: - WATER REPORT NO. ______

DESCRIPTION: SPECIAL DATE: 10/10/72

RECEIVED FROM: RANNEY WELL

	% TRANS.	PPM F^-	pH			
No. 16	70	13	9.1	10-10-72	01:00 AM	6+7 O.
6#7 Closed 17	68	14	9.1		02:00	"
18	66	15	9.2		03:00	6+7 Close.
19	65	16	9.2		04:00	6+7 O
20	38	29	9.4		04:45	6 OF
21	39	29	9.4		05:00	6 OF
22	42	28	9.4		06:00	6 OF
23	43	28	9.4		07:00	6 OF
24	47	27	9.4		08:20	None Off
25	52	24	9.3		09:15	None Off
26	51	24	9.3		09:45	None Off
27	25	24	9.1		10:15	None Off
28	21	27	9.1		10:40	#5 OF
29	22	26	9.1		11:00	#5 OF
30	22	26	9.1		12:05	#5 OF
31	22	26	9.1		13:00	#5 OF
32	22	26	9.1		14:00	#5 OF

Analyzed By: JP Approved By: Jr Date: 10/11/72

(3)

ORMET CORPORATION
Reduction Division

ANALYTICAL LABORATORY

OR 62 Rev. 1066

SAMPLE: Water

REPORT NO.

DESCRIPTION: Special

DATE: 10/10/72

RECEIVED FROM: Ranney Well

	% Trans.	PPM F^-	pH			~~None~~
33	25	24	9.1	10/10/72	15:00	NON OFF
34	25	24	9.1		16:00	ON
35	21	25	9.1		16:30	#3 OF
36					18:00	3 O
37					19:00	3 O
38					20:00	3 O
39					21:00	
40					22:00	
41					23:00	2 O
42					24:00	2 O
43				10/11/72	01:00	2 O
44					02:00	2 O
45					02:30	NON OF
46					03:00	NON OF
47					04:00	NO OF
48					04:30	#1
49					05:15	10

Analyzed By: JP Approved By: Date:

ORMET CORPORATION
Reduction Division

ANALYTICAL LABORATORY

OR 62 Rev. 1066

SAMPLE: WATER REPORT NO.

DESCRIPTION: SPECIAL DATE: 10/12/72

RECEIVED FROM: RANNEY WELL

	% TRANS.	PPM F⁻	pH
50 - 6:30 1 OFF 10/11/72			
51 - 8:00 1 OFF			
52 - 9:00 6+7+8 OFF			
53 - 9:30 6+7+8 OFF		6	8.7
54 - 10:30 6+7+8 OFF		6	
55 - 11:30		7.4	
56 - 12:30 6+7+8 OFF		8.2	
57 - 13:30 6+7+8 OFF		8.8	
58 - 14:30		9.6	
59 - 15:30 6+7+8 OFF		10	
60 - 16:30 6+7+8 OFF			
61 - 08:00 10/12/72			

Analyzed By: Approved By: Date:

8-440+ +721 - Ec. L.

FRED H. KLAER, JR. & ASSOCIATES
CONSULTING GROUND-WATER GEOLOGISTS AND HYDROLOGISTS
16 LELAND AVENUE COLUMBUS, OHIO 43214
P.O. BOX 3496
~~PHONE 888-6533~~

November 6, 1972

cc:
Eng FILE
CDL(3)
WTB
✓HLR
JMB
BSP

The Ormet Corporation
Box 176
Hannibal, Ohio 43931

Attention: Mr. Bernard S. Paidock

Gentlemen,

We are enclosing eight copies of our report, "Phase 3 - Ranney Well Lateral Test-Ormet Corporation" dated November 3, 1972. If additional copies are needed, please let us know.

We will be glad to discuss this report and our recommendations with you at your convenience.

Very truly yours,

FRED H. KLAER, JR. & ASSOCIATES

Fred H. Klaer Jr.

Fred H. Klaer, Jr.
Consulting Ground-Water Geologist
and Hydrologist

FHKJr:eh

Encl.

PHASE 4. INTERCEPTOR WELL
PUMPING TESTS
PLANT WATER SUPPLY 1973
ORMET CORPORATION

For

THE ORMET CORPORATION
ALUMINUM REDUCTION DIVISION
HANNIBAL, OHIO

By

FRED H. KLAER, JR. AND ASSOCIATES
Consulting Geologists and Hydrologists
Columbus, Ohio

February 12, 1973

TABLE OF CONTENTS

SYNOPSIS

INTRODUCTION:

The results of a detailed pumping test on the Ranney Well including the closing of individual horizontal laterals, one at a time, and the resulting changes in chemical quality of the water pumped, indicated that contamination was reaching the Ranney well mainly through Lateral 7 extending northward and landward from the caisson. The results of the pumping tests were presented in our report, "Phase 3-Ranney Well Lateral Test, Ormet Corporation" dated November 3, 1973. As a result of Phase 3 of the detailed hydrogeological survey of the plant water supply, it was concluded that it might be possible to intercept the contaminated water and prevent it from reaching the Ranney well by installing and pumping an interceptor well north of Lateral 7. The water pumped was expected to be of much poorer quality than that from the Ranney well and would have to be reused or treated if the interceptor well was pumped on a long term basis.

Fred H. Klaer, Jr. and Associates was authorized by Ormet Purchase Order No.OH-077311, dated November 13, 1972, as Phase 4 of the detailed hydrogeological survey of the plant water supply to provide a 12-inch interceptor well and temporary pumping equipment, and to perform a detailed pumping test to prove the validity of intercepting the contaminated water, all in accordance with our proposal of October 28, 1972.

The 12-inch interceptor well was installed by the Layne-Ohio Company of Columbus, Ohio, to a depth of 100 feet and was equipped with 10 feet of stainless dteel commercial well screen and temporary electric deep well turbine pump.

A step drawdown test was run on December 20,1972, and pumping of the interceptor well was started on December 26, 1972, and was continued without interruption until January 25, 1973, when the test covered by this contract was considered completed. The following report describes in detail the well installation, the test pumping, and the changes observed in water levels and chemical quality.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS:

The installation and pumping of an interceptor well north of the Ranney well for a period of 30 days was successful in intercepting the contamined water causing poor quality water in the Ranney well. After an initial period of pumping the interceptor well at a rate of 500 gpm for 23 days, the fluoride content of the Ranney well water was reduced to 1.9 ppm and the transmittance was increased to 98 percent. Further reduction of the pumping rate to 350 gpm and continued pumping reduced the fluoride content of the Ranney well water to 1.6 ppm and raised the transmittance to 99 percent.

The control of the chemical quality in the Ranney well will require continuous monitoring and adjustment of pumping rate from the interceptor well, especially during periods of higher river stage or increased pumping from the Ranney well. The use of the interceptor well will increase the effectiveness of the Ormet Ranney well to prevent the movement of contaminated water toward the Omal Ranney well.

In order to maintain continuous interception of contaminated water, we wish to make the following recommendations:

1. Arrangements must be made to pipe the water pumped from the interceptor well to some point of treatment or reuse. The permanent installation should include a control valve, flow meter, and means of measuring the pumping level in the interceptor well.

2. A standby deep well turbine pump capable of pumping at least 500 gpm against a total head of 129 feet should be obtained. This pump should be equipped with an air line pressure gage and fittings, so that the pumping level in the interceptor well can be measured. In the event of failure of the present pump, it should be possible to replace it with the standby pump in a short period of time.

3. Monitoring of pumping levels and water samples should be taken daily from both the interceptor well and the Ranney well and should be recorded in permanent form. Periodic adjustments of pumping rates may be necessary to maintain suitable water quality.

4. Monthly samples of water should be continued from TH-3 and the 8-inch well to monitor the changes in the chemical quality of water leaving the disposal pond area.

5. The depth-of-water gage in the Ormet Ranney well should be checked to assure that the pumping level indicated is correct.

Respectfully submitted,

FRED H. KLAER, JR. & ASSOCIATES
Consulting Geologists & Hydrologists

by Fred H. Klaer Jr.

Fred H. Klaer, Jr.
Certified Professional Geologist No.75
Registered Geologist California No.1798

FHKJr:eh

REPORT

INTERCEPTOR WELL.

The interceptor well is located 178 feet north of the outside of the caisson of the Ranney well and about 12 feet east of the northern extension of Lateral 7. The location of the interceptor well is shown in Plate 1 and Figure 1.

The log of the interceptor well as reported by the driller is as follows:

0 - 5	Top Soil
5 - 55	Sandy yellow clay and gravel
55 - 100	Sand and gravel
100 - 101	Blue Clay

Static water level - 80 feet.

The elevation of the top of the casing is 666.55 feet above mean sea level.

The well is equipped with 10 feet of nominal 12 inch OD Cook stainless steel well screen set between depths of 89 and 99 feet below ground level. The screen slot opening is 0.125 inch. The casing extends about 1.7 feet above land surface. The clear opening through the screen is 10-5/8 inches. The top of the screen is fitted with a lead packer, which is swedged out against the inside of the 12 inch casing. The well screen is closed at the bottom.

The well was also equipped with a Layne electric deep well turbine pump, 25 HP, 440 volt, 3 phase, 60 cycle motor, 7 stage, 1750 rpm, 8 inch SKHC bowls, set with 90 feet of pump column and 5 feet of bowl section.

STEP TEST - INTERCEPTOR WELL.

On December 20, 1972, a step test was run on the interceptor well, during which the well was pumped at rates of 155, 250, 380, and 513 gpm with each rate being held constant for about 30 minutes. The test pump was equipped with a 6 inch valve, 6 inch orifice tube, and a 4 inch free discharge orifice. The static level prior to pumping was 79.74 feet below the top of the casing or 78.04 feet below ground level.

The total drawdown in a well is made up of an aquifer or formation drawdown plus an additional well loss due to friction loss through the well screen and turbulent flow within the well, and may be expressed as:

$$s = BQ + CQ^2$$

where s is the total drawdown in feet
B = aquifer drawdown factor
C = well loss factor
Q = pumping rate in gpm.

From the step test, the aquifer drawdown factor (B) was determined as 0.00811 and the well loss factor (C) was 0.000002. At a pumping rate of 500 gpm, the aquifer drawdown for 30 minutes of pumping was 4.06 feet and the well loss was 0.50 feet, and the total drawdown was 4.56 feet. The apparent specific capacity was 109.6 gpm per foot of drawdown and the theoretical efficiency of the well was 89 percent. The 12 inch well was properly constructed and developed.

Since the results of the step test showed that the interceptor well could be pumped safely at 500 gpm, this rate was selected for the continuous pumping test.

CONTINUOUS PUMPING TEST OF INTERCEPTOR WELL.

On December 26, 1972, continuous pumping of the interceptor well was started at 1245 hrs. at a rate of 500 gpm. Automatic water level recorders were installed on TH-1 and TH-15 and periodic measurements of water level were made in the Ranney well. During the first three days of the continuous pumping test from December 26 to 28, measurements were made and samples were collected by personnel of Fred H. Klaer, Jr. and Associates. During the period December 29, 1972, to January 25, 1972, the test was run by Ormet personnel. All chemical analyses were made in the Ormet chemical laboratory.

The water levels in the Ranney well during the period December 26 to 28, 1972, were measured from the hole in the pump base of the now unused 1500 gpm sanitary water pump in the southwest corner of the caisson using an electric tape. The height of the measuring point was measured as 1.07 feet above the top floor of the caisson, the elevation of which is 666.00 feet MSL. The elevation of the measuring point was therefore 667.07 feet MSL. Water levels in the Ranney well were determined by Ormet personnel by reading the water depth gage, the zero of which is reported to be 572.0 feet MSL. Check measurements on January 4 and 25, 1973, indicate that the elevations determined by electric tape measurements were 2.7 to 3 feet lower than those determined by the water depth gage. It is recommended that the water depth gage readings be checked carefully to determine the accuracy of the water depth gage.

The changes in water level in the Ohio River, TH-1, TH-15, the Ranney well and the interceptor well and changes in chemical quality in the water from the Ranney well and from the interceptor well during the first three days of the test are shown in detail in Figures 5 and 6. Similar data for the entire test period are shown in Figures 7 and 8. In Figures 6 and 8, the fluoride content of the interceptor well water is 10 times that shown by the scale on the left side of the graphs. The data on which the graphs are based are tabulated in Tables 1 - 8 in the Appendix.

It is known from previous observations that high stages of the Ohio River usually result in a decrease in fluoride and an increase in transmittance in the Ranney well water. During the early part of December, 1972, prior to any pumping from the interceptor well, the Ohio River rose to a level of 617.5 feet MSL on December 10 and then dropped to 605.7 feet MSL on December 20. The fluoride content of the Ranney well water ranged from 28 ppm on December 5 to 18 ppm on December 11, following the high river level on December 10. The transmittances for the same dates were 41 percent and 60 percent, respectively. The river rose again and crested at 613.4 feet MSL on December 24 and generally dropped back to about normal pool stage of 602.2 feet MSL on December 30, 1972. The river remained at or below pool stage during the remainder of the test.

On December 20, 1972, prior to the start of the step test on the interceptor well, the fluoride content of the Ranney well water was 27 ppm and the transmittance was 31 percent. During the step test, during which the interceptor well was pumped at several different rates over a period of 3½ hours, the fluoride content of the Ranney well dropped to 18 ppm and the transmittance increased to 42 percent.

Prior to the start of the continuous pumping of the interceptor well on December 26, 1972, the fluoride content in the Ranney well was 26 ppm and the transmittance was 36 percent. During the first five hours of pumping the interceptor well, these were reduced to 11.8 ppm and 72 percent, respectively.

During the same period, the fluoride content of the interceptor well water dropped from 275 ppm to 230 ppm. The water pumped was black and had zero transmittance.

Continuous pumping of the interceptor well remained at 500 gpm until January 17, 1972. By this date, the pH of the Ranney well water had dropped to 8.0, the fluoride content had dropped to 1.9 ppm and the transmittance had increased to 98 percent and had shown no significant changes during the preceeding two days. The pumping level in the interceptor well dropped to a depth of 92.5 feet, only about 2.5 feet above the pump intake.

In order to maintain the pumping level above the pump intake and to determine the effects of a lower pumping rate on the chemical quality of the Ranney well water, the pumping rate from the interceptor well was reduced to 400 gpm at 1000 hours on December 17, with no change in quality in the Ranney well water. The pumping rate was reduced again to 300 gpm at 1430 hours on January 18, but after about four days, a small increase in fluoride and a small decline in transmittance occurred. Therefore on January 22, at 1330 hours, the pumping rate from the interceptor well was increased to 350 gpm. At the end of the test on January 25, 1973, the Ranney well water had a pH of 7.9, a fluoride content of 1.6 ppm, and a transmittance of 99 percent. In the interceptor well, the pH was 10.0, and the fluoride content was 88 ppm. At the end of the test, the pumping level in the interceptor well was four to five feet below the pumping level in the Ranney well and about 25.6 feet below river level.

GENERAL CONCLUSIONS:

The installation and pumping of a 12-inch diameter interceptor well about 78 feet north of lateral 7 of the Ormet Ranney well was successful in intercepting almost completely the flow of contaminated water to the Ranney well. During the test, a pumping rate of 350 gpm from the interceptor well appeared to be adequate to maintain an acceptable chemical quality of the water from the Ranney well which was being pumped at 1450 gpm. During the last 27 days of the continuous pumping test, the Ohio River was at or below normal pool stage, when we would expect poorer infiltration conditions from the river and poorer water quality conditions. During higher river stages, we would expect increased infiltration rates and an improvement in the chemical quality of the Ranney well water by natural dilution.

The relationships between the pumping rate from the interceptor well, the pumping rate from the Ranney well and the chemical quality of the Ranney well water are apparently quite sensitive and must be determined in more detail by field observation. Continuous monitoring and adjustment of the pumping rate may be necessary, particularly during periods of increased pumping from the Ranney well. We believe that the pumping from the interceptor well must be continuous in order to maintain a complete interception of the contaminated water.

RECOMMENDATIONS:

It is our opinion that the continuous use of the interceptor well will maintain the chemical quality of the Ranney well water within the necessary limits to permit its use for industrial water supply. The continuous pumping of the interceptor well will also add to the barrier effect of the Ormet Ranney well in preventing the movement of contaminated water downstream toward the Omal Ranney well. It is our opinion that the use of the interceptor well is the most economical means of assuring the continued use of the Ranney well as a source of industrial water supply.

In order to maintain continuous interception of the contaminated water, we recommend that the following steps be taken:

1. Arrangements must be made to pipe the water pumped from the interceptor well to some point for chemical treatment or reuse. We believe that such piping should be capable of handling at least 500 to 600 gpm. The permanent installation should include a control valve, flow meter and means of measuring the pumping level.

2. A standby electric-driven deep well turbine pump should be obtained, capable of pumping at least 500 gpm against a total discharge head large enough to allow for a pumping lift of 95 to 98 feet plus the necessary friction losses in the pipeline to the point of discharge. Such a pump should be equipped with an airline, pressure gage and fittings so that the pumping level in the well can be measured. In the event of failure of the present pump, it should be possible to pull the present pump and install the

standby pump in a short period of time. It may be necessary to replace the present starting equipment with a starter of larger capacity.

3. Measurements of pumping level and water samples should be taken daily from the interceptor well and the Ranney well and should be recorded in a permanent form. Periodic adjustment of the pumping rate from the interceptor well may be necessary to maintain the water quality of the Ranney well with the minimum pumping rate from the interceptor well.

4. Monthly samples of water from TH-3 and the 8-inch well in the disposal pond area should be continued and the chemical analyses should be reviewed periodically.

5. The depth of water gage in the Ranney well should be checked to be sure that the gage reading shows the correct elevation of pumping level in the Ranney well.

APPENDIX

WATER LEVEL AND CHEMICAL DATA.

TABLE 1. Water levels

COMPUTATION SHEET

SUBJECT: ORMET CORPORATION, HANNIBAL, OHIO
INTERCEPTOR WELL

PAGE 1
ACC. NO.
FILE

COMPUTED BY: FK DATE: 1/29/73 CHECKED BY: DATE:

MP ELEVATION 666.72

DATE	TIME	D.W.	ELEV.	DATE	TIME	D.W.	ELEV.
12/26/72	1035	79.81	586.91	1/4/73	0930	88½	578.2
	1120	79.80	586.92	1/5/73	0910	88.6	577.9
	1227	79.74	586.98	1/8/73	1120	89.4	577.3
	1245	PUMP ON @ 500 gpm		1/9/73	1020	89.8	576.9
	1250	84.01	582.71	1/10/73	1300	90.19	576.53
	1255	84.07	582.65	1/11/73	1330	90.7	576.02
	1305	84.14	582.58	1/12/73	1430	91.05	575.67
	1315	84.22	582.50	1/15/73	1420	92.58	574.14
	1330	84.32	582.40	1/16/73	0900	92.75	573.97
	1347	84.36	582.36	1/16/73	1430	93.0	573.7
	1400	84.44	582.28	1/17/73	0900	93.5	573.2
	1415	84.51	582.21	1/17/73	1000	RATE REDUCED TO 400gpm	
	1445	84.56	582.16	1/17/73	1430	92.5	574.2
	1517	84.60	582.12	1/18/73	0900	92.25	574.5
	1545	84.67	582.05	1/18/73	0930	RATE REDUCED TO 300gpm	
	1645	84.73	581.99	1/18/73	1430	91.25	575.5
	1745	84.82	581.90	1/19/73	0930	91.03	575.7
12/27/72	0835			1/22/73	0830	91.50	575.2
	0945	85.45	581.27	1/22/73	1330	RATE INCREASED TO 350gpm	
	1045	85.46	581.26	1/23/73	0830	91.50	575.2
	1215	85.47	581.25	1/24/73	0830	91.00	575.7
	1345	85.48	581.24	1/25/73	0830	90.75	576
	1445	85.49	581.23				
	1545	85.52	581.20				
	1645	85.55	581.17				
12/28/72	0845	85.88	580.84				
	1005	85.90	580.82				
	1100	85.92	580.80				
	1245	85.96	580.76				
	1425	86.17	580.55				
	1610	86.12	580.62				
1/2/73	0930	88	578.7				
1/3/73	0900	88½	578.2				

TABLE 2. Water levels
COMPUTATION SHEET

SUBJECT ORMET CORPORATION, HANNIBAL, OHIO
RANNEY WELL.

PAGE 1
ACC. NO.
FILE

COMPUTED BY DATE CHECKED BY DATE

M.P. ELEVATION - 667.07'

DATE	TIME	D.W	ELEV.	RATE
12/26/72	1925	82.04	585.03	1790
	1125	82.07	585.00	1790
	1222	82.04	585.03	1790
	1245	INTERCEPTOR WELL ON @ 500gp.m		
	1300	82.13	584.94	1790
	1315	82.14	584.93	1790
	1325	82.16	584.91	1790
	1345	82.20	584.87	1790
	1405	82.22	584.85	1790
	1420	82.28	584.79	1790
	1445	82.28	584.79	1790
	1515	82.32	584.75	1790
	1543	82.36	584.71	1790
	1643	82.41	584.66	1790
	1742	82.46	584.61	1790
12/27/72	0820	83.00	584.07	1790
	0945	83.02	584.05	1790
	1045	83.04	584.03	1790
	1240	83.10	583.97	1790
	1345	83.10	583.97	1790
	1445	83.10	583.97	1790
	1545	83.10	583.97	1790
	1645	83.12	583.95	1790
12/28/72	0810	83.41	583.66	1790
	1010	83.46	583.61	1790
	1055	83.52	583.55	1790
	1240	83.51	583.56	1790
	1420	83.81	583.26	2280
	1615	83.72	583.35	1790
		GAGE		
1/2/73	0930	12+	584+	1750
1/3/73	0900	12-	584-	1750
1/4/73	0930	12	584	1750
1/4/73	1110	D.W 85.78	581.29	1750
		G-12'		

DATE	TIME	GAGE	ELEV.	RATE
1/5/73	0910	11.8	583.8	1750
1/8/73	0820	11.2	583.2	1750
1/9/73	1020	10.8	582.5	1700
1/10/73	1300	10.5	582.5	1800
1/11/73	1330	10.2	582.2	1730
1/12/73	1430	10.0	582.0	1750
1/15/73	1400	9.0	581.0	1720
1/16/73	0900	9.0	581.0	1720
1/16/73	1430	9.0	581.0	1720
1/17/73	0900	9.0	581.0	1720
1/17/73	1000	INTERCEPTOR WELL RATE 400gpm		
1/17/73	1430	9.0	581.0	1720
1/18/73	0900	8.75	580.75	1720
1/18/73	0930	INTERCEPTOR WELL RATE 300gp		
1/18/73	1430	9.0	581.0	1720
1/19/73	0930	9.0	581.0	1720
1/22/73	0830	8.5	580.5	1720
1/22/73	1330	INTERCEPTOR WELL RATE 350gp		
1/22/73	1330			1450
1/23/73	0830	9.0	581.0	1450
1/24/73	0830	9.0	581.0	1450
1/25/73	0830	9.0	581.0	1450
1/25/73	1110	DW 91.49	575.58	1450
		G 9.0'		

TABLE 3. Water levels

COMPUTATION SHEET

SUBJECT: ORMET CORPORATION - HANNIBAL, OHIO
TEST HOLE 1

PAGE ______ ACC. NO. ______ FILE ______ DATE ______

COMPUTED BY: TK DATE: 1/30/72 CHECKED BY: ______

M.P. ELEV. - 664.00

DATE	TIME	DEPTH TO WATER	ELEV.	DATE	TIME	DEPTH TO WATER	ELEV.
12/26/72	1105	74.91	589.09	12/27/72	2000	75.66	588.34
	1200	74.91	589.09		2100	75.69	588.31
	1300	74.91	589.09		2200	75.70	588.30
	1400	74.93	589.07		2300	75.72	588.28
	1500	74.96	589.04		2400	75.73	588.27
	1600	75.00	589.00	12/28/72	0100	75.75	588.25
	1700	75.03	588.97		0200	75.78	588.22
	1800	75.06	588.94		0300	75.80	588.20
	1900	75.10	588.90		0400	75.82	588.18
	2000	75.13	588.87		0500	75.84	588.16
	2100	75.16	588.84		0600	75.86	588.14
	2200	75.20	588.80		0700	75.89	588.11
	2300	75.22	588.78		0800	75.92	588.08
	2400	75.25	588.75		0900	75.93	588.07
12/27/72	0100	75.28	588.72		1000	75.95	588.05
	0200	75.31	588.69		1100	75.96	588.04
	0300	75.34	588.66		1200	75.97	588.03
	0400	75.36	588.64		1300	75.97	588.03
	0500	75.37	588.63		1400	76.00	588.00
	0600	75.40	588.60				
	0700	75.43	588.57				
	0800	75.47	588.53				
	0900	75.48	588.52				
	1000	75.49	588.51				
	1100	75.49	588.51				
	1200	75.49	588.51				
	1300	75.50	588.50				
	1400	75.52	588.48				
	1500	75.54	588.46				
	1600	75.56	588.44				
	1700	75.60	588.40				
	1800	75.61	588.39				
	1900	75.62	588.38				

TABLE 4. Water levels

COMPUTATION SHEET

SUBJECT ORMET CORPORATION - HANNIBAL, OHIO

TEST HOLE 15

PAGE ______ ACC. NO. ______ FILE ______ DATE ______

COMPUTED BY JK DATE 1/30/73 CHECKED BY ______

MP-ELEV. = 663.59

DATE	TIME	DEPTH TO WATER	ELEV.	DATE	TIME	DEPTH TO WATER	ELEV.
12/26/72	1040	78.04	585.55	12/27/72	2000	78.58	585.01
	1100	78.05	585.54		2100	78.59	585.00
	1200	78.07	585.52		2200	78.60	584.99
	1300	78.09	585.50		2300	78.60	584.99
	1400	78.11	585.48		2400	78.61	584.98
	1500	78.13	585.46	12/28/72	0100	78.62	584.97
	1600	78.15	585.44		0200	78.64	584.95
	1700	78.17	585.42		0300	78.65	584.94
	1800	78.19	585.40		0400	78.66	584.93
	1900	78.21	585.38		0500	78.67	584.92
	2000	78.23	585.36		0600	78.69	584.90
	2100	78.25	585.34		0700	78.71	584.88
	2200	78.28	585.31		0800	78.73	584.86
	2300	78.30	585.29		0900	78.74	584.85
	2400	78.32	585.27		1000	78.76	584.83
12/27	0100	78.34	585.25		1100	78.78	584.81
	0200	78.36	585.23		1200	78.80	584.79
	0300	78.38	585.21		1300	78.84	584.75
	0400	78.40	585.19				
	0500	78.41	585.18				
	0600	78.43	585.16				
	0700	78.44	585.15				
	0800	78.46	585.13				
	0900	78.47	585.12				
	1000	78.48	585.11				
	1100	—	—				
	1200	78.49	585.10				
	1300	78.51	585.08				
	1400	78.50	585.09				
	1500	78.51	585.08				
	1600	78.51	585.08				
	1700	78.53	585.06				
	1800	78.53	585.06				
	1900	78.56	585.03				

TABLE 5. Water levels

COMPUTATION SHEET

SUBJECT ORMET CORPORATION HANNIBAL, OHIO
RIVER STAGE AT DAM 15 UPPER GAGE (7A.M.)

PAGE ______
ACC. NO. ______
FILE ______
DATE ______

COMPUTED BY ______ DATE ______ CHECKED BY ______

0 OF GAGE = 586.8' MSL.

DATE	GAGE	ELEV.	DATE	GAGE	ELEV.
12/13/72	22.1	608.9	1/15/73	15.8	602.6
12/14	21.9	608.7	1/16	15.6	602.4
12/15	21.5	608.3	1/17	15.7	602.5
12/16	22.8	609.6	1/18	15.6	602.4
12/17	22.1	608.9	1/19	15.4	602.2
12/18	20.7	607.5	1/20	15.3	602.1
12/19	19.9	606.7	1/21	15.0	601.8
12/20	18.9	605.7	1/22	15.2	602.0
12/21	20.5	607.3	1/23	15.2	602.0
12/22	21.5	608.3	1/24	15.3	602.1
12/23	23.9	610.7	1/25	15.3	602.1
12/24	26.6	613.4			
12/25	23.3	610.1			
12/26	22.1	608.9			
12/27	21.2	608.0			
12/28	20.3	607.1			
12/29	17.4	604.2			
12/30	15.1	601.9			
12/31	14.2	601.0			
1/1/73	12.8	599.6			
1/2	14.0	600.8			
1/3	14.6	601.4			
1/4	14.1	600.9			
1/5	15.5	602.3			
1/6	15.6	602.4			
1/7	15.1	601.9			
1/8	13.6	600.4			
1/9	14.4	601.2			
1/10	15.3	602.1			
1/11	15.2	602.0			
1/12	15.8	602.6			
1/13	15.6	602.4			
1/14	15.4	602.2			

TABLE 6. Water levels

COMPUTATION SHEET

SUBJECT ORMET CORP. HANNIBAL, OHIO
TEST HOLE 1

PAGE 1
ACC. NO.
FILE
DATE

COMPUTED BY ED DATE 1/29/73 CHECKED BY
ELEV. M.P. = 664.00

DATE	TIME	D.W	ELEV	DATE	TIME	D.W	ELEV
12/13/72	1150	75.00	589.00	1/15/73	800	81.38	582.70
12/14	800	74.85	589.15	1/16	800	81.63	582.37
12/15	800	74.66	589.34	1/17	800	81.83	582.17
12/16	800	74.64	589.36	1/18	800	81.90	582.10
12/17	800	74.71	589.29	1/19	800	81.93	582.07
12/18	800	74.66	589.34	1/20	800	82.06	581.94
12/19	800	74.91	589.09	1/21	800	82.14	581.86
12/20	800	75.15	588.85	1/22	800	82.21	581.79
12/21	800	75.27	588.73	1/23	800	82.09	581.91
12/22	800	75.28	588.72	1/24	800	82.00	582.00
12/23	800	75.17	588.83	1/25	800	81.91	582.09
12/24	800	74.90	589.10				
12/25	800	74.80	589.20				
12/26	800	74.86	589.14				
12/27	800	75.47	588.53				
12/28	800	75.92	588.02				
12/29	800	76.36	587.64				
12/30	800	76.80	587.20				
12/31	800	77.20	586.80				
1/1/73	800	77.70	586.30				
1/2	800	78.02	585.98				
1/3	800	78.44	585.56				
1/4	800	78.70	585.30				
1/5	800	78.91	585.09				
1/6	800	79.06	584.94				
1/7	800	79.22	584.77				
1/8	800	79.41	584.59				
1/9	800	79.73	584.27				
1/10	800	80.01	583.99				
1/11	800	80.33	583.67				
1/12	800	80.71	583.29				
1/13	800	80.92	583.08				
1/14	800	81.14	582.86				

TABLE 7. Water levels

COMPUTATION SHEET

SUBJECT ORMET CORP. HANNIBAL, OHIO
TEST HOLE 15

PAGE 1
ACC. NO.
FILE
DATE

COMPUTED BY FK DATE 1/[illegible]/73 CHECKED BY

M.P. ELEV- 663.59

DATE	TIME	D.W.	ELEV.	DATE	TIME	D.W.	ELEV.
12/13/72	1115	77.12	586.47	1/15	800	83.33	580.26
12/14	8.00	76.92	586.67	1/16	800	83.54	580.05
12/15	800	76.72	586.87	1/17	800	83.70	579.89
12/16	800	76.88	586.71	1/18	800	83.77	579.82
12/17	800	77.15	586.44	1/19	800	83.77	579.82
12/18	800	77.32	586.27	1/20	800	83.92	579.67
12/19	800	77.65	585.94	1/21	800	84.04	579.55
12/20	800	77.97	585.62	1/22	800	84.12	579.47
12/21	800	78.16	585.43	1/23	800	84.12	579.47
12/22	800	78.24	585.35	1/24	800	84.06	579.53
12/23	800	78.14	585.45	1/25	800	84.00	579.59
12/24	800	77.86	585.73				
12/25	800	77.92	585.67				
12/26	800	78.00	585.59				
12/27	800	78.46	585.13				
12/28	800	78.73	584.86				
12/29	800	79.09	584.50				
12/30	800	79.37	584.22				
12/31	800	79.63	583.96				
1/1/73	800	80.01	583.58				
1/2	800	80.28	583.31				
1/3	800	80.56	583.03				
1/4	800	80.76	582.83				
1/5	800	80.90	582.69				
1/6	800	81.05	582.54				
1/7	800	81.20	582.39				
1/8	800	81.36	582.23				
1/9	800	81.69	581.90				
1/10	800	82.00	581.59				
1/11	800	82.26	581.33				
1/12	800	82.60	580.99				
1/13	800	82.85	580.74				
1/14	800	83.08	580.51				

TABLE 8. Chemical Analyses

COMPUTATION SHEET

SUBJECT: ORMET CORPORATION HANNIBAL, OHIO
CHEMICAL ANALYSES

PAGE: 1
ACC. NO.
FILE

COMPUTED BY ______ DATE ______ CHECKED BY ______ DATE ______

	INTERCEPTOR WELL					RANNEY WELL					
DATE	TIME	pH	F ppm	RATE GPM	SAMPLE NO.	TIME	pH	F ppm	% TRANS	RATE GPM	SAMPLE NO.
12/19/72							9.6	25	52		
12/20							9.6	23	48		
12/20						1025	9.2	27	31	1800	1
12/20	STEP TEST ON INTERCEPTOR WELL STARTED AT 1250 12/20/72										
12/20	1255	10.1	300	172	2	1254	9.2	27	27	1800	3
	1325	10.1	275	172	4	1300	9.2	26	28	1800	5
	1420	10.1	267	250	6	1320	9.2	25	28	1800	7
	1500	10.1	230	513	8	1425	9.2	23	32	1800	9
	1600	10.1	223	380	10	1457	9.1	20	35	1800	11
						1555	9.1	18	42	1800	13
	STEP TEST COMPLETED AT 1600 12/20/72										
12/21							9.5	22	50		
12/26							9.5	24	50		
12/26							9.1	26	36		1
	INTERCEPTOR WELL STARTED PUMPING CONTINUOUSLY AT 500 GPM AT 1245, DECEMBER 26, 1972										
12/26	1250	10.2	275	500	2						
	1348	10.2	270	500	4	1345	9.1	19.0	45	1790	3
	1450	10.2	255	500	6	1445	9.1	16.0	57	1790	5
	1546	10.2	255	500	8	1545	9.1	15.0	62	1790	7
	1645	10.2	250	500	10	1645	9.1	13.2	67	1790	9
	1745	10.2	230	500	12	1745	9.1	11.8	72	1790	11
12/27	0840	10.1	200	500	14	0825	9.0	9.4	72	1790	13
	0915	10.1	200	500	16	0945	9.0	9.8	72	1790	15
	1245	10.1	185	500	18	1245	9.0	9.4	72	1790	17
	1445	10.1	185	500	20	1445	9.1	9.0	74	1790	19
	1645	10.1	185	500	22	1645	9.0	9.8	74	1790	21
12/28	0815	10.0	180	500	24	0815	9.0	7.2	78	1790	23
	1100	10.0	180	500	26	1100	8.8	6.6	81	1790	25
	1245	10.0	180	500	28	1240	8.9	5.5	83	1790	27
	1425	10.0	180	500	30	1420	9.1	8.8	69	2280	29
	1610	10.0	180	500	32	1615	8.9	6.0	78	1790	31

TABLE 8. Chemical Analyses, (Continued)

COMPUTATION SHEET

SUBJECT ORMET CORPORATION, HANNIBAL, OHIO
CHEMICAL ANALYSES

PAGE 2
ACC. NO.
FILE

COMPUTED BY ______ DATE ______ CHECKED BY ______ DATE ______

	INTERCEPTOR WELL						RANNEY WELL					
DATE	TIME	pH	F ppm	RATE gpm	SAMPLE NO	TIME	pH	F ppm	% TRANS	RATE gpm	SAMPLE NO.
12/29/72				500			8.8	6.0	83		
	1425	10.1	174				8.8	5.	84		
12/30/72		9.9	180		34		8.5	5.2	86		33
12/31/72		9.8	168		36		8.5	4.7	88		35
1/1/73		9.8	162		38		8.2	3.9	90		37
1/2/73		10.2	155				8.5	4.0	89	1750	
1/3/73		10.2	147				8.4	4.0	92	1750	
1/4/73		10.2	155				8.2	3.0	94	1750	
1/5/73		10.1	153				8.2	2.8	96	1750	
1/8/73		9.8	155				8.1	2.6	96	1750	
1/9/73		10.0	155				8.1	2.7	95	1700	
1/10/73		10.0	110				8.2	2.4	97	1800	
1/11/73		10.0	132				8.0	2.3	96	1730	
1/12/73		9.9	140				8.0	2.2	96	1750	
1/15/73		10.0	132				8.0	2.0	98	1720	
1/16/73		9.8	115				8.1	2.0	98	1720	
1/17/73		10.0	110				8.0	1.9	98	1720	
1/17/73	1000	INTERCEPTOR WELL PUMPING RATE REDUCED TO 400 gpm									
1/17/73	1500	9.9	150	400			8.0	1.8	97	1720	
1/18/73		10.0	92	400			8.0	1.9	96	1720	
1/18/73	0930	INTERCEPTOR WELL PUMPING RATE REDUCED TO 300 gpm									
1/18/73	1430	9.9	100	300			8.0	1.9	97	1720	
1/19/73		9.9	100	300			8.0	1.8	97	1720	
1/22/73		10.1	110	300			8.1	3.6	94	1720	
1/22/73	1330	INTERCEPTOR WELL PUMPING RATE INCREASED TO 350 gpm									
1/23/73		9.9	100	350			7.9	1.9	99	1450	
1/24/73		10.0	80	350			7.9	1.5	99	1450	
1/25/73		10.0	88	350			7.9	1.6	99	1450	

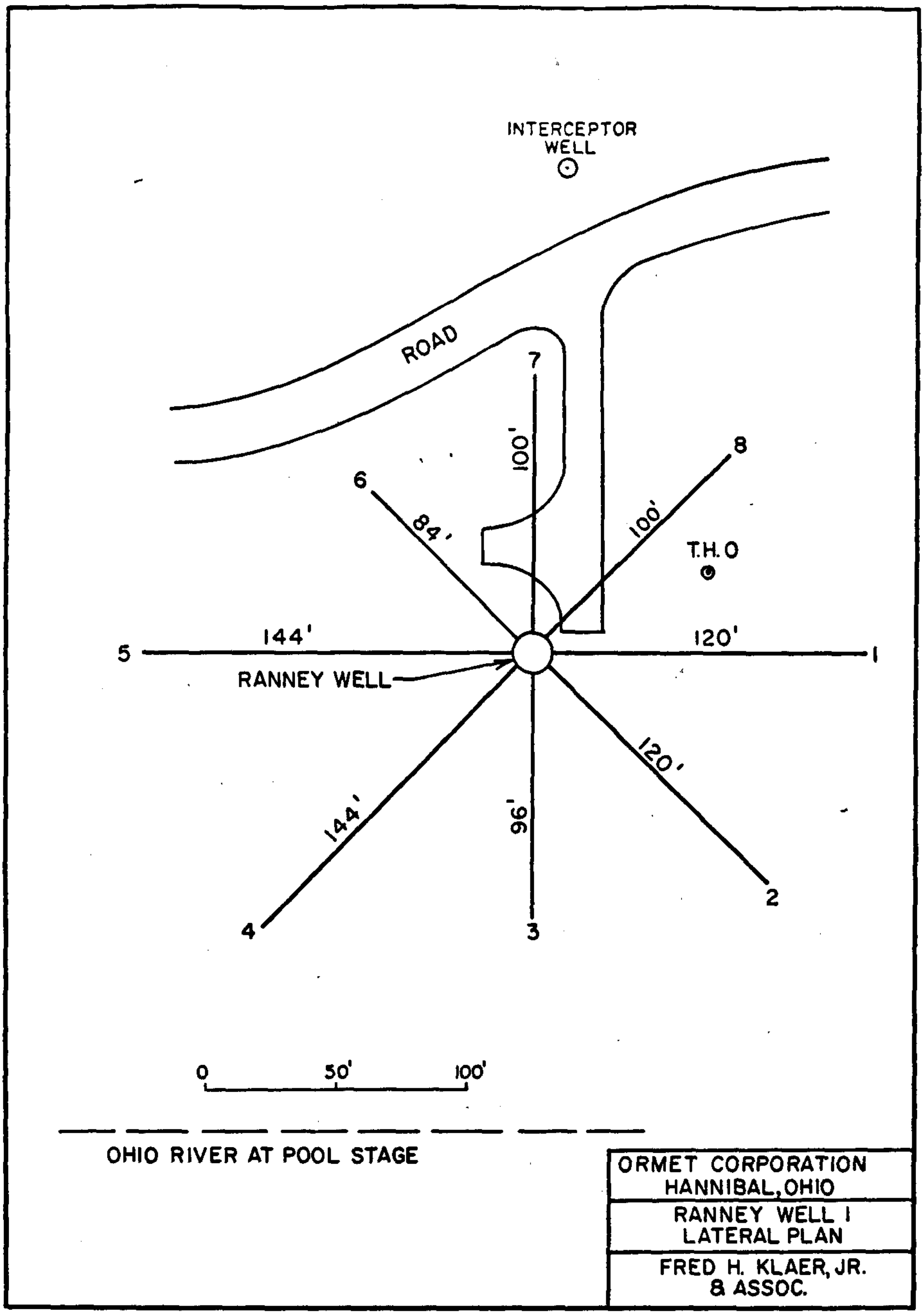
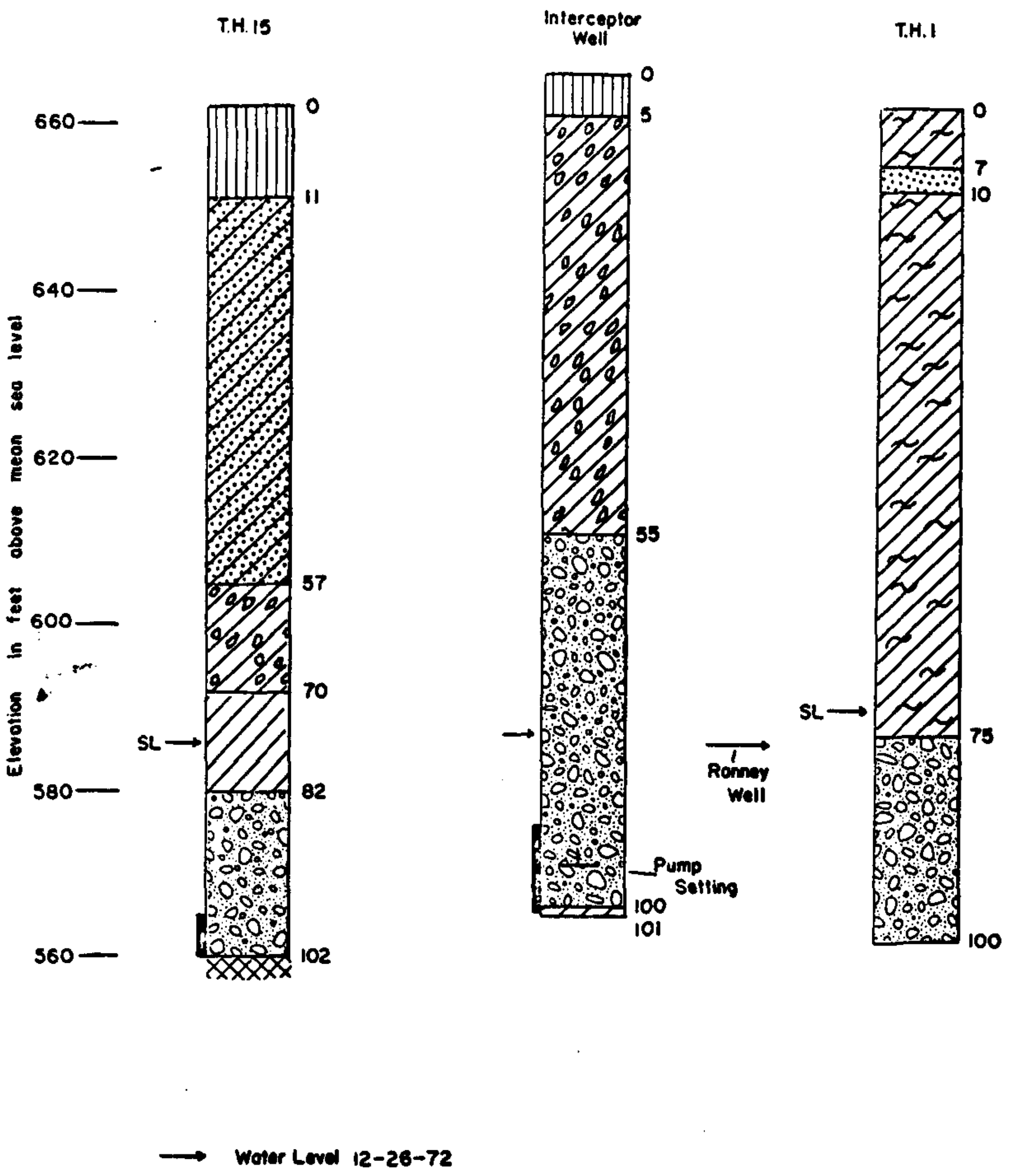

INTERCEPTOR WELL
ROAD
7
100'
8
6
84'
100'
T.H. O
5
144'
120'
1
RANNEY WELL
120'
144'
96'
4
3
2
0
50'
100'
OHIO RIVER AT POOL STAGE
ORMET CORPORATION
HANNIBAL, OHIO
RANNEY WELL I
LATERAL PLAN
FRED H. KLAER, JR.
& ASSOC.

FIGURE I

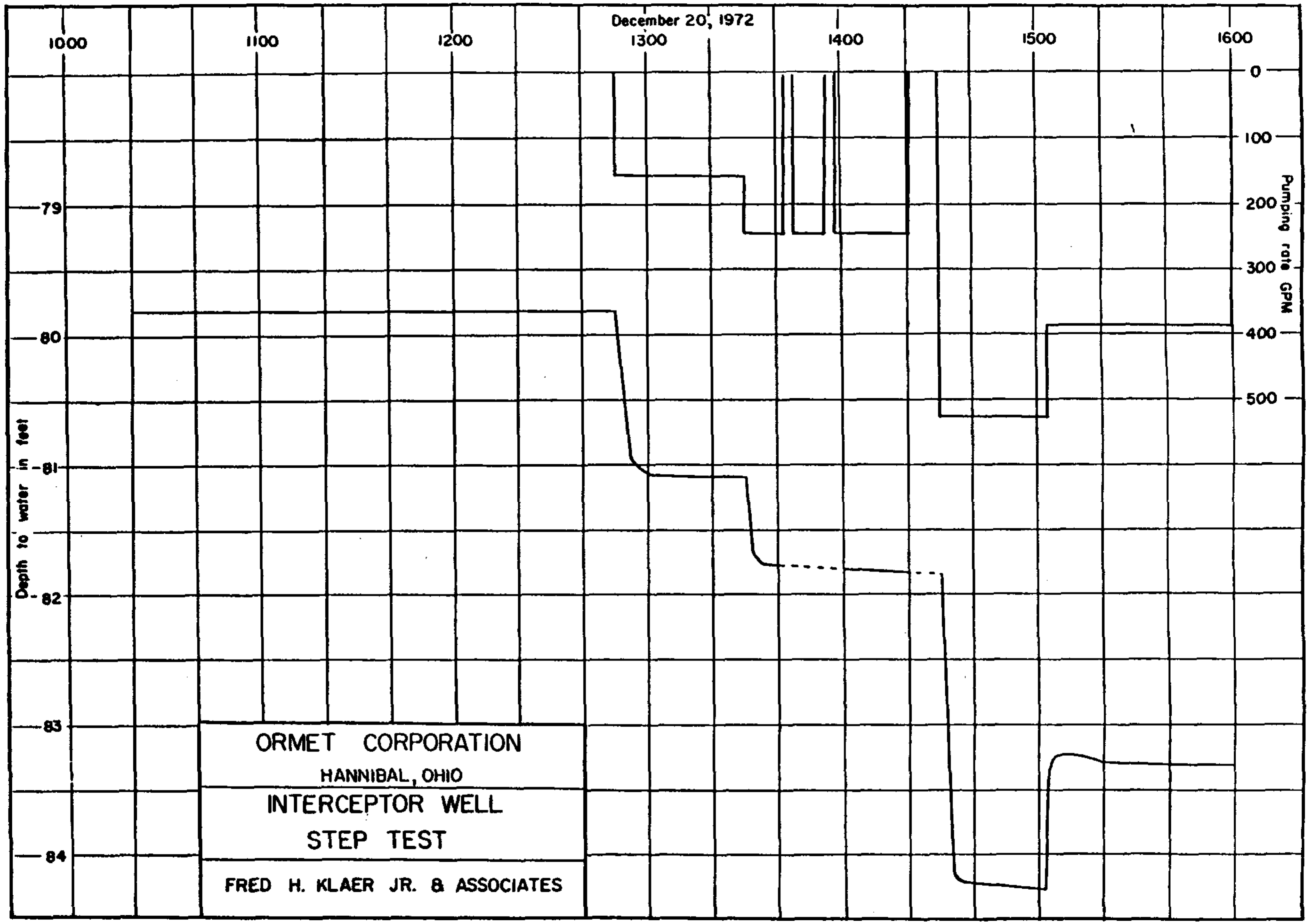


ORMET CORPORATION
HANNIBAL, OHIO

LOG OF
INTERCEPTOR WELL

FRED H. KLAER JR. & ASSOCIATES

FIGURE 2.



December 20, 1972
1000
1100
1200
1300
1400
1500
1600
Depth to water in feet
79
80
81
82
83
84
Pumping rate GPM
0
100
200
300
400
500
ORMET CORPORATION
HANNIBAL, OHIO
INTERCEPTOR WELL
STEP TEST
FRED H. KLAER JR. & ASSOCIATES

FIGURE 3.

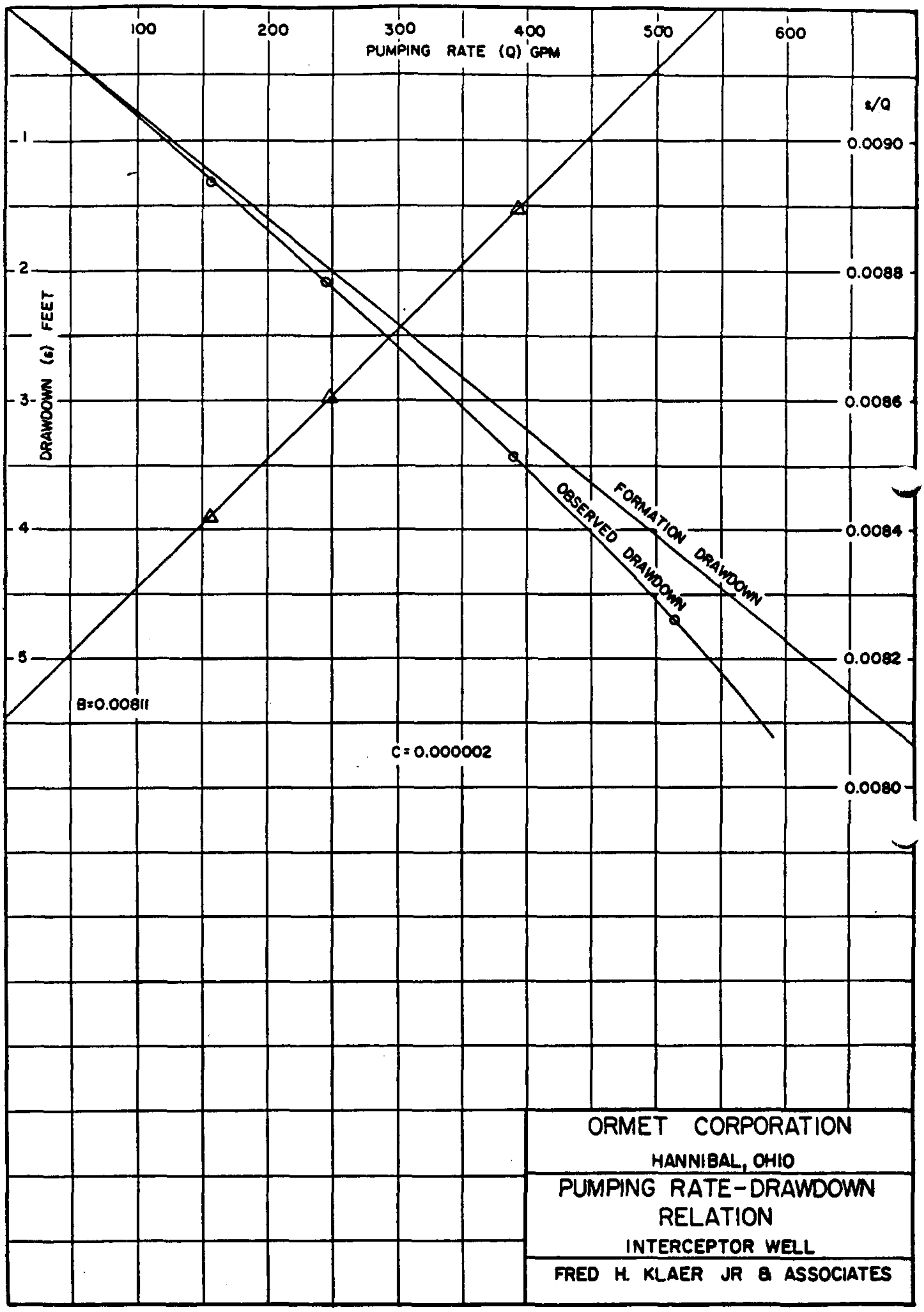

100
200
300
400
500
600
PUMPING RATE (Q) GPM
s/Q
0.0090
0.0088
0.0086
0.0084
0.0082
0.0080
1
2
3
4
5
DRAWDOWN (s) FEET
FORMATION DRAWDOWN
OBSERVED DRAWDOWN
B=0.00811
C=0.000002
ORMET CORPORATION
HANNIBAL, OHIO
PUMPING RATE-DRAWDOWN
RELATION
INTERCEPTOR WELL
FRED H. KLAER JR & ASSOCIATES

FIGURE 4.

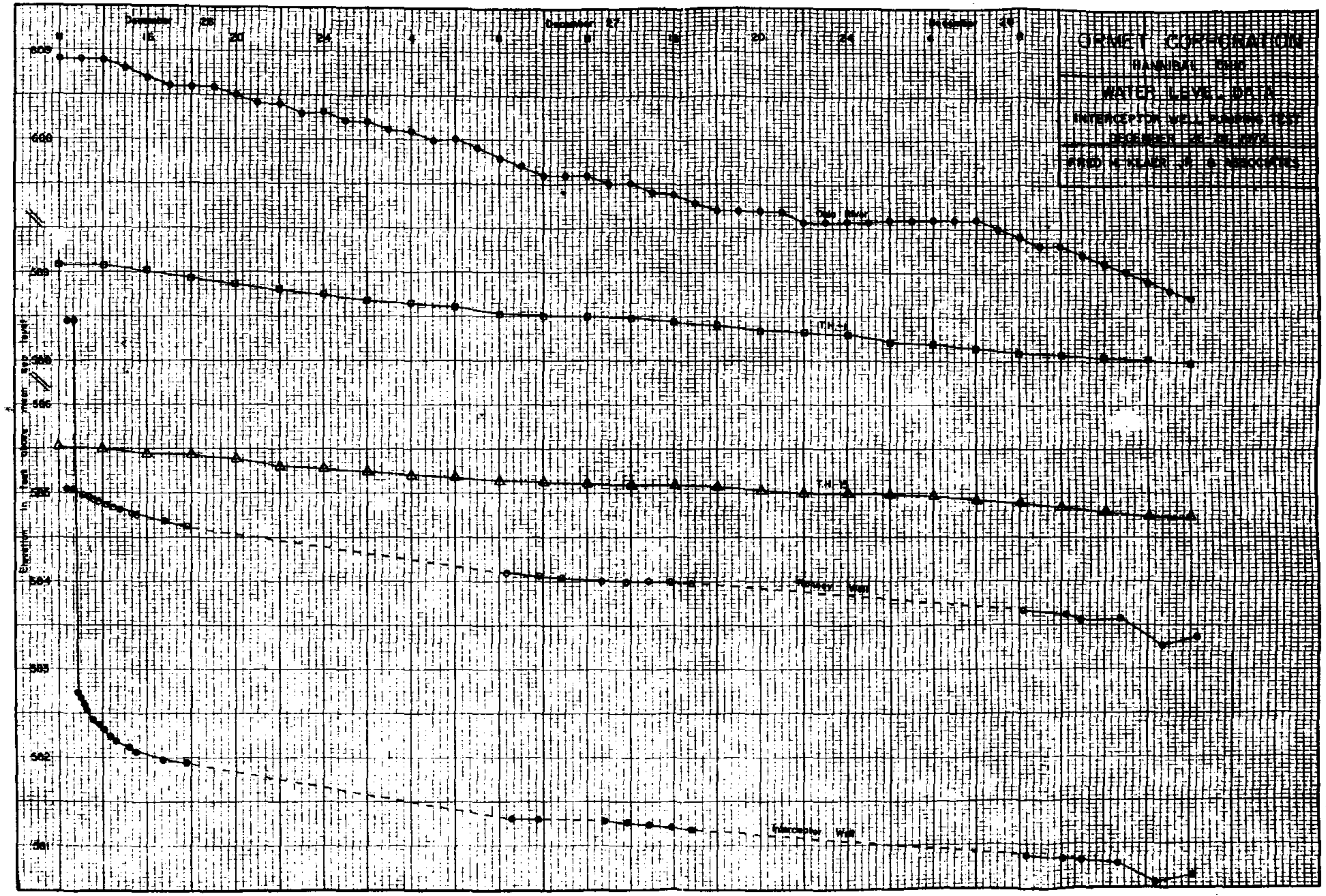
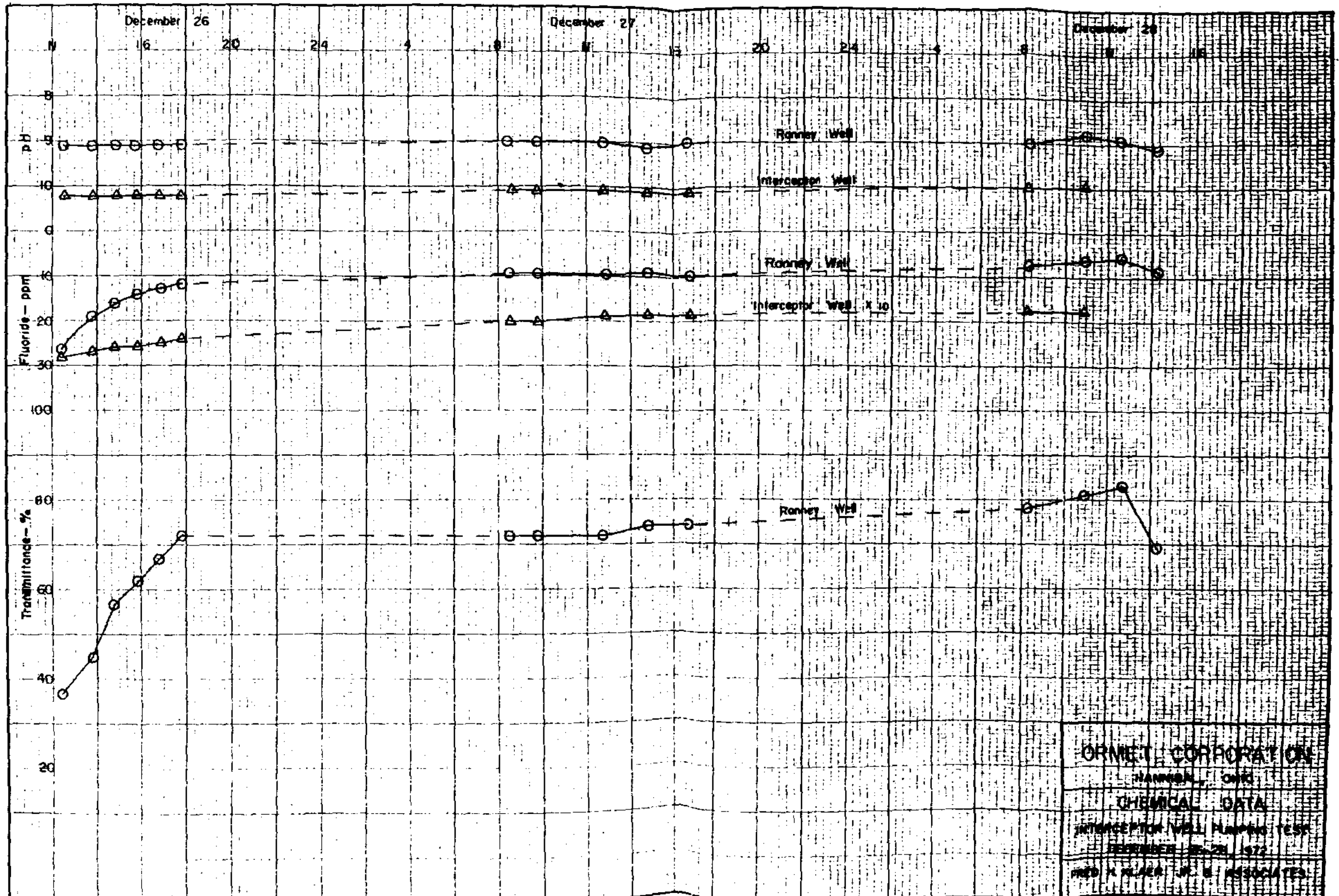

ORMET CORPORATION
HANNIBAL, OHIO
WATER LEVEL DATA
INTERCEPTOR WELL PUMPING TEST
Elevation in feet above mean sea level
Interceptor Well

FIGURE 6.



December 26
December 27
December 28
pH
Fluoride – ppm
Transmittance – %
Ranney Well
Interceptor Well
Ranney Well
Interceptor Well x 10
Ranney Well
ORMET CORPORATION
HANNIBAL, OHIO
CHEMICAL DATA
INTERCEPTION WELL PUMPING TEST
DECEMBER 26-28, 1972
FRED H. KLAER, JR. & ASSOCIATES

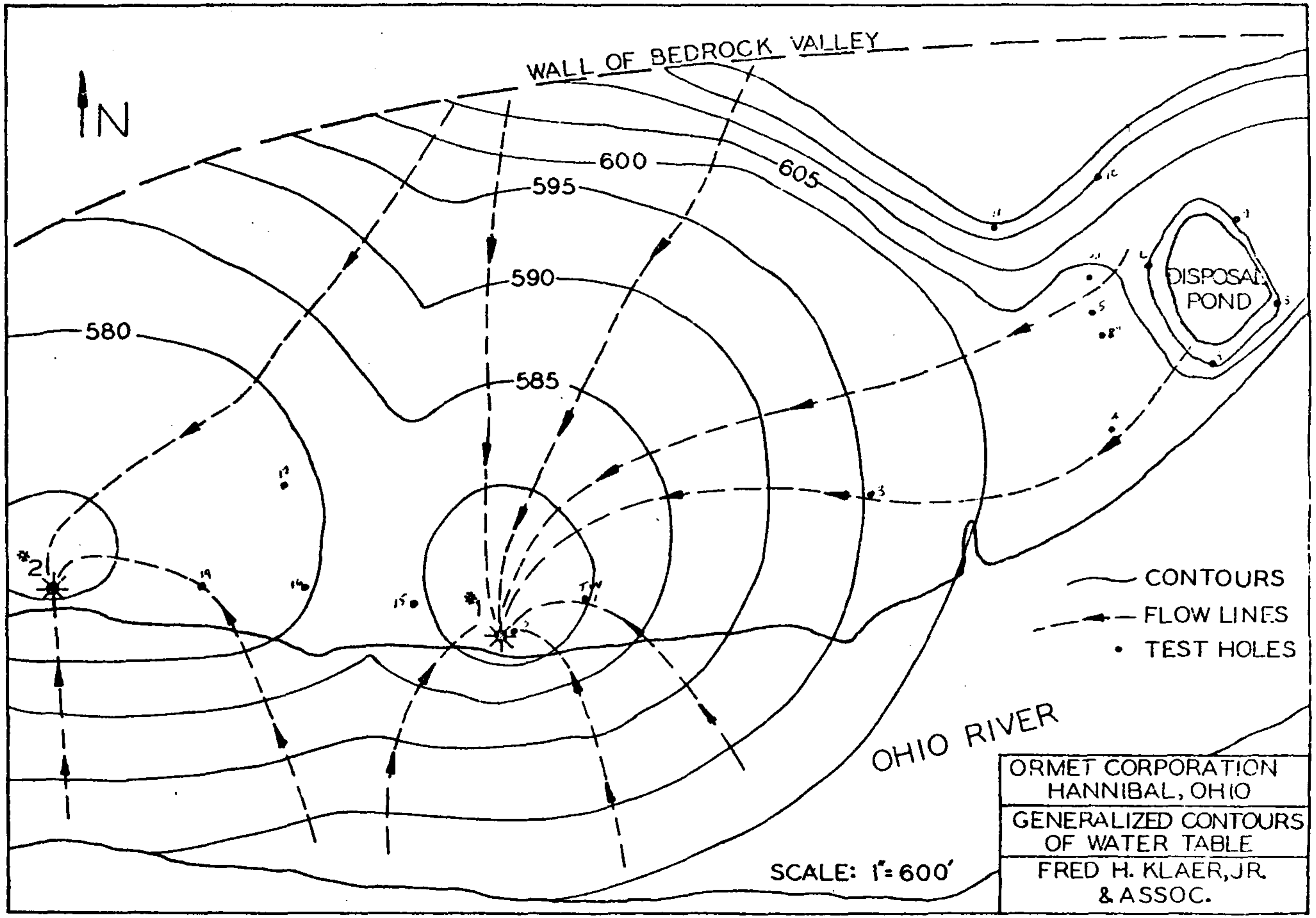
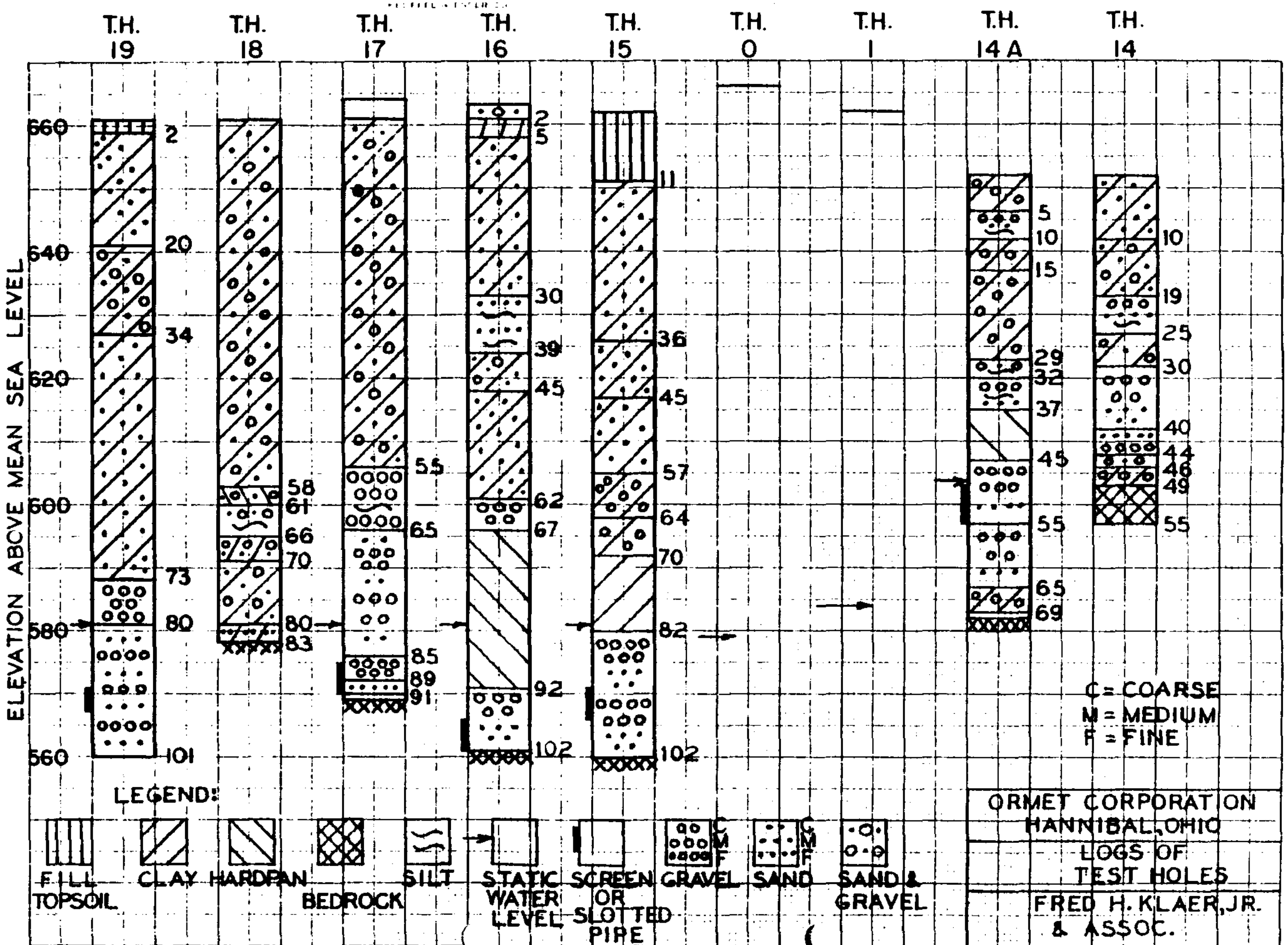


FIGURE 5 (REVISED)


T.H. 19
T.H. 18
T.H. 17
T.H. 16
T.H. 15
T.H. 0
T.H. 1
T.H. 14 A
T.H. 14
ELEVATION ABOVE MEAN SEA LEVEL
660
640
620
600
580
560
2
20
34
73
80
101
58
61
66
70
80
83
55
65
85
89
91
2
5
30
39
45
62
67
92
102
11
36
45
57
64
70
82
102
5
10
15
29
32
37
45
55
65
69
10
19
25
30
40
44
46
49
55
C = COARSE
M = MEDIUM
F = FINE
LEGEND:
FILL TOPSOIL
CLAY
HARDPAN
BEDROCK
SILT
STATIC WATER LEVEL
SCREEN OR SLOTTED PIPE
GRAVEL
C
M
F
SAND
C
M
F
SAND & GRAVEL
ORMET CORPORATION
HANNIBAL, OHIO
LOGS OF TEST HOLES
FRED H. KLAER, JR. & ASSOC.